NOVEMBER 1957

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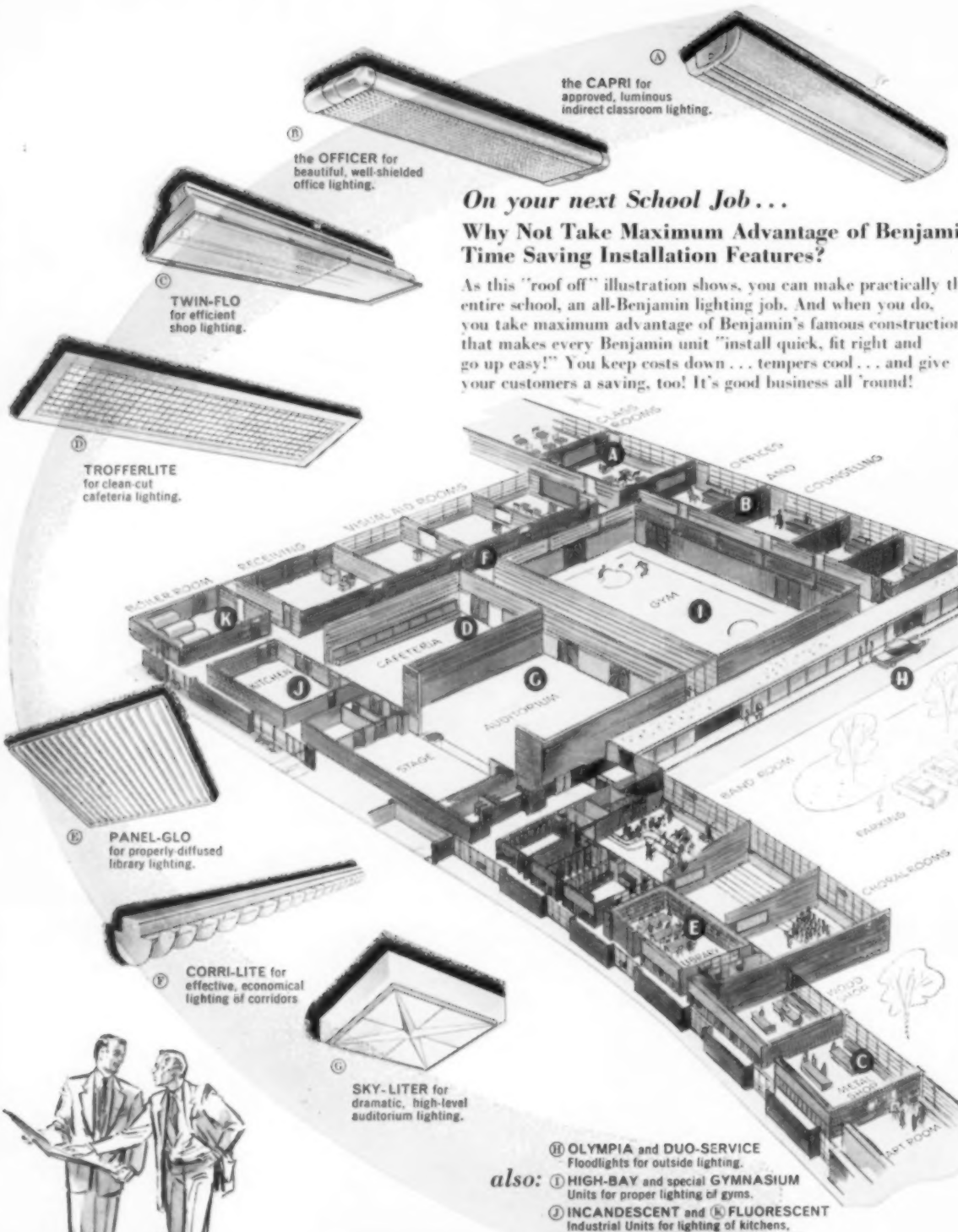
ILLUMINATING ENGINEERING

Journal of the
ILLUMINATING ENGINEERING SOCIETY



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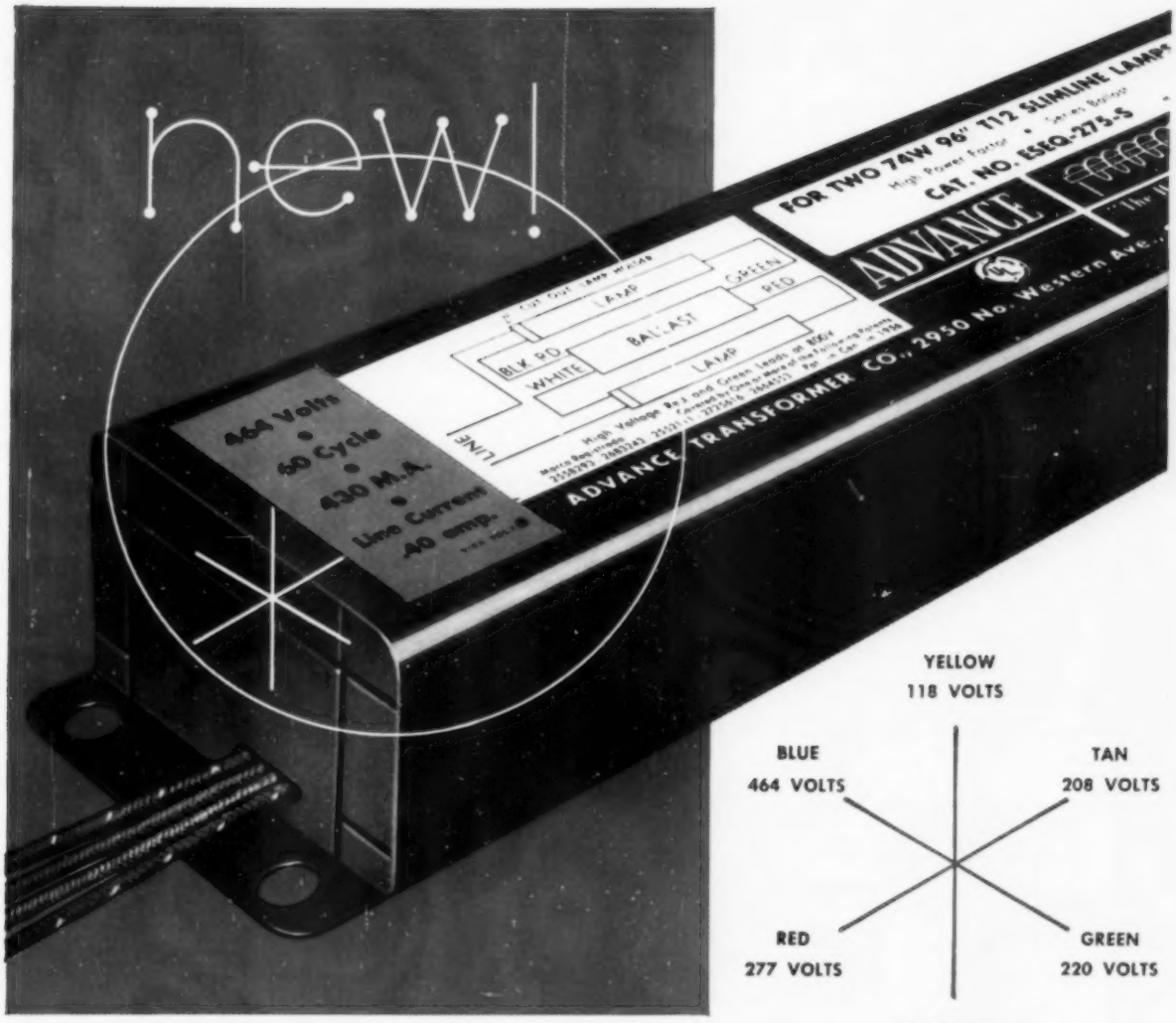

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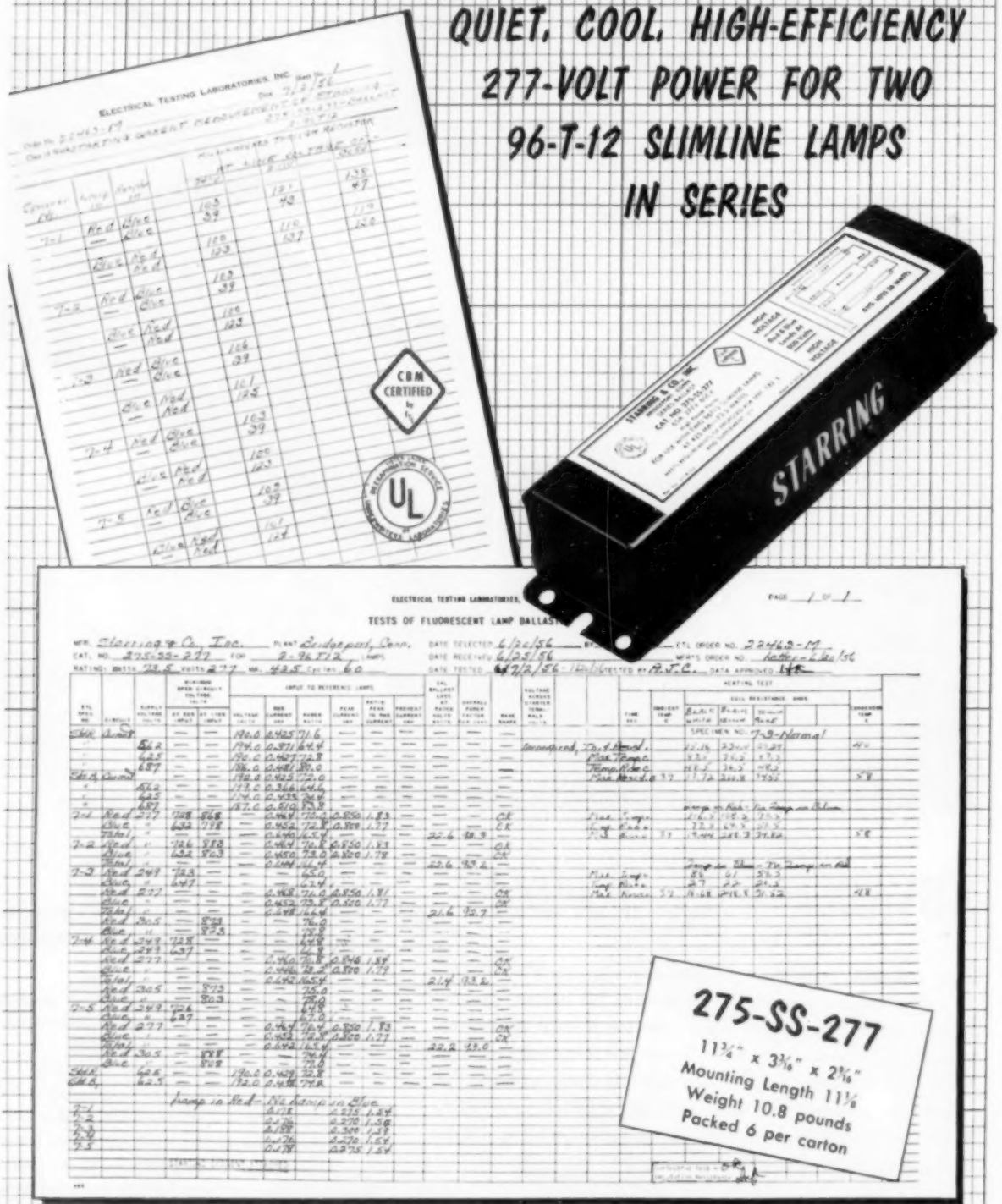

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ILLUMINATING ENGINEERING

THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

November 1957

Vol. LII, No. 11

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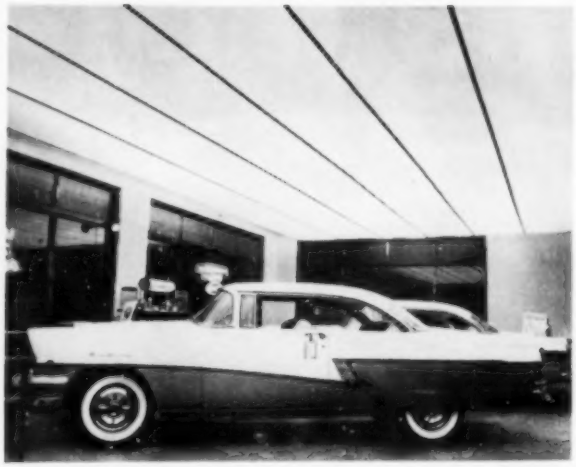

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Not only students but others benefit by the quality of the lighting in this library which is attached to a school in Cambridge, Mass. Both the stacks and the reading tables are softly, glarelessly illuminated with Litecontrol No. 5100 series recessed Holophane lens fixtures.

Some of these standard, cost-saving fixtures are arranged to fit in the corners of the rectangles. In addition, there are two rows of single lamp fixtures in the soffit over the bookshelves. There are also a few special two-foot square fixtures which appear across the center of the room and tie in attractively with the shape of the air diffusers.

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Henry J. Poehling
Class II

Edna Fortier
Class I

My Most Interesting Lighting Job Winners

Now There Are Two!

Class II — Commercial and Industrial Lighting

Well away on its sixth year as a national contest, the race for "the most interesting" commercial or industrial lighting job was this year keener than ever. A total of 55 Sections and Chapters held contests, with 145 entries. All of the 11 Regions held further contests, featuring 28 entries, and 8 of *their* first-prize winners went to Atlanta for the finals.

Not only has the size of this contest grown, year after year, but the nature of its entries has represented ever-increasing excellence in lighting design. Even runners-up at the Section level have given the judges a hard time.

Starting with last year's competition, a silver cup, the Goddard Trophy, was added to the prize money. The cup, of sterling silver, nine inches high, is engraved with the name of the winner, and a smaller silver replica given as a permanent memento.

First Prize was awarded to Henry J. Poehling, Midwestern Region, St. Louis Section. See page 552 for details of his job. Other national winners: Second, L. T. Genise, Michigan. Third, Earl I. Dinsmore, North Texas. Fourth, W. F. Rosacker, Eastern Pennsylvania.

Class I — Residential Lighting

A Newcomer, as a separate classification in the National MMILJ Contest this year, was home lighting. Interesting lighting jobs in the home have been entries before, and indeed, have been national winners (see November 1956 I.E., p. 717). This year, however, was the first time residential lighting installations competed only against one another, at the Section level, again for the Region's top job, and finally at the National contest. The Lighting Service Committee, sponsors of MMILJ, established the separate classification for Residential Lighting more or less as an experiment. They are in a position now to judge its success.

Within the Section and Chapter contests, 58 entries competed for the right to represent their Sections at the Regional contests. At the semi-final Regionals, there were 18 home lighting contestants. Of these, 7 competed for prizes at the National Contest in Atlanta.

First Prize went to Mrs. Edna Fortier, South Central Region, New Orleans Section. Details of her prize-winning installation are given on page 556 of this issue. Other national winners: George E. Matilo, Cleveland Section, second. Jack T. Cottingham, Oregon Section, third. Edwin Schnoll, Milwaukee, fourth.

FIRST PRIZE
CLASS II

The year's "Most Interesting Lighting Job" was, appropriately enough, an integral part of the architectural design of one of the year's most outstanding buildings. In the photograph at right, the evening sky silhouettes the vaulted domes of the structure, the sweeping lines themselves suggesting flight. Note the two-way skylights separating each of the vaulted domes, lending form to the building as viewed from outside, and high-level illumination to the interior. In the photo at left, by day the glass panels on the roof side permit natural light to flood the main concourse.

Harmony of Architecture and Lighting

Main Passenger Concourse. Indirect lighting of the vaulted ceilings, from concealed color-improved mercury vapor lamps is supplemented at night by slimline strips behind the plastic diffused two-way skylights, themselves a part of the architectural pattern.

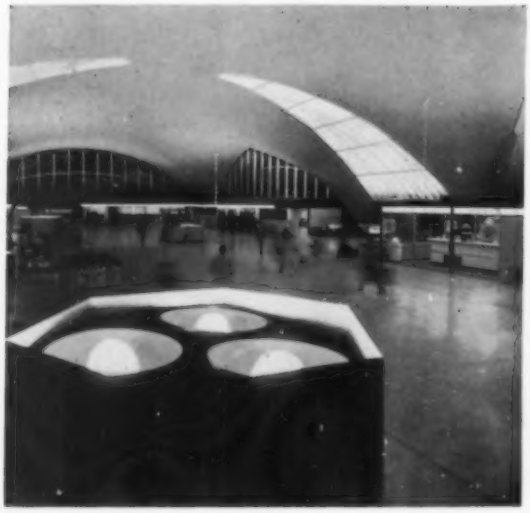
at St. Louis Air Terminal Building

No other building in the past year has been given such sincere admiration, in architectural and engineering publications and in weekly news magazines, as the Air Terminal Building, Lambert Field, St. Louis, Missouri. This architectural masterpiece has won for the architects (Hellmuth Yamaski & Leinweber) and the engineers (Ferris & Hamig) many awards for their contribution to the advancement of architecture and engineering; the most recent honor counted this building as one of "The Ten Buildings in America's Future." Everyone who has been associated with the planning and the building of this magnificent structure has taken joyful pride in the result. Not the least of these is the lighting engineer, Henry J. Poehling, whose unique lighting design swept up First Prize — in St. Louis Section of I.E.S. — in Midwestern Region — and finally had the honor of being judged the "Most Interesting Lighting Job of the Year" in the National I.E.S. Contest, held in Atlanta, September 11.

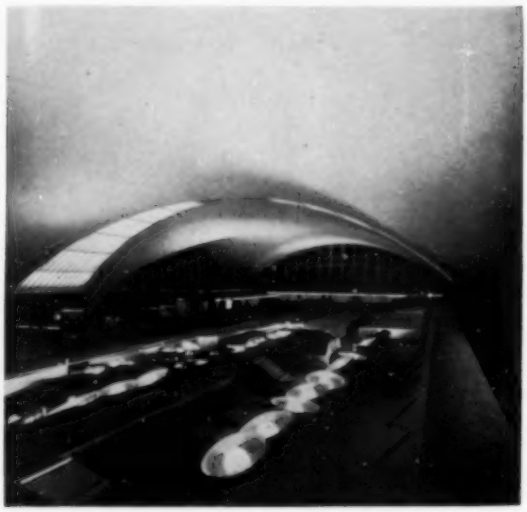
In the design of the building, the arch, one of the architect's best known structural devices, has been used in a modern expression of form, and is accomplished with present day materials, glass and aluminum. Consistent with the venturesome building design, the lighting too is bold and pioneering in concept. Color-improved mercury lamps, usually associated with outdoor application, have been used in a fresh new way — as indirect sources for an outstanding effect. Nighttime illumination of the glass skylight panels, in a sweeping design, serves the dual purpose of high level lighting indoors and

Henry J. Poehling
St. Louis Section
Midwestern Region

Mr. Poehling is a Lighting Sales Engineer with E. H. Lauth & Associates, St. Louis, Mo.



A "down-in" look at the cleverly concealed mercury vapor lamps which provide totally indirect light to the arched ceilings. Units are located on top of the seven-foot high Concession Kiosks and the ticket counters . . .



and inside the several advertising display cases. Each of the 1000-watt lamps is separately switched; each has its own transformer, set on Fibreglas cushions. A total of 110 such units are installed.

integration of the architectural pattern, as seen from outside the building, as well as inside.

Main Concourse

An almost Cathedral-like effect has been achieved by the architects, and abetted by the lighting design, in this great room. The area here is 412 feet long, 120 feet wide, with the center of the vaulted ceilings 32 feet above the floor. The sweep of these lofty arches is enhanced by indirect lighting from color-improved mercury vapor lamps, concealed atop the Concession kiosks, above ticket sales areas, and within advertising display cases. A total of 110 such units are installed, using 1000-watt color-improved mercury vapor lamps. Each is separately switched to permit unlimited control of illumination levels to suit the time of day and the extent of traffic. Each lamp has its own transformer set on Fibreglas cushions to minimize transmission of noise and vibration through the metal decking. General lighting in the circulating areas of the room measures 50 to 75 footcandles, after five months' operation.

The Concession Kiosks are 7-foot high enclosures, nicely spaced about the huge interior. Tickets are sold here, and other concessions such as snack-bars and kitchen facilities are located in these enclosures. The kiosks themselves are independently

Deplaning passengers approach the building from the field level, through "fingers," enclosed walk spaces from the terminal building to plane areas on the field. Lighting is from special luminaires using 40-watt rapid-start lamps with ballasts between the acrylic channels.

lighted with luminous ceilings using slimline lamps above corrugated plastic panels. Illumination level on the ticket and serving counters is 75 to 100 footcandles.

Skylight

The possibility of color distortion from the mercury vapor lamps has been averted with the illumination from slimline strips with plastic diffusers in the two-way skylights separating each of the vaulted domes. Glass panels on the roof side permit natural light to flood the area during the day. At night, the slimline strips between the layers of room glass and the plastic panels, nicely saturate the area with cool white fluorescent lighting, off-setting the "lemon cast" of the mercury vapor lighting. Another important feature of this phase of the lighting system, of course, is its harmony with the architectural pattern. It has been made to look a part of the architecture. At night, with the roof glass panels illuminated, an interesting pattern is seen from outside of the building, toward the sky and the lower sides of the building, as well as indoors.

Baggage Pick-up Area. Here 33-inch fluorescent lamps are used, as the size most satisfactorily providing good balance between ceiling spaces and luminous elements. Baggage is quickly identified by high levels of illumination from downlights.

Other Areas

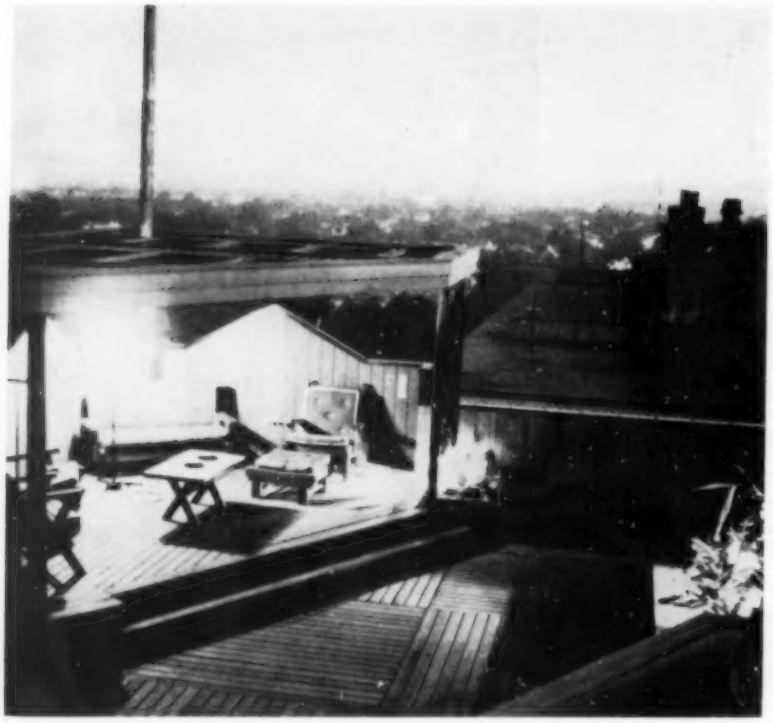
Passengers being deplaned at Lambert Field approach the building from the field level, through "fingers" or enclosed walk spaces. These are lighted with special luminaires using two 40-watt rapid-start lamps, enclosed in channel shaped acrylic plastic, separated in the center by a metal ballast enclosure. This provides a source of low brightness used on wide centers and low mounting having a general design well suited to the interior.

From the fingers, the baggage pick-up room is reached through corridors on the second level, lighted by 24-inch square recessed fluorescent units. An unusual feature of the lighting for the baggage pick-up is that 33-inch fluorescent lamps were used: this size most satisfactorily provided a good balance between ceiling spaces and luminous elements.

From the pick-up room, the air passenger ascends the escalator to the Main Passenger Concourse, where he gets the full impact of the Spirit of St. Louis in this air age.

Unobtrusive, clean and pleasant was the general feeling desired for corridor lighting. This area leads the passenger from the baggage pick-up to the escalators, and thence to the beautiful view of the Main Concourse. Two-foot square recessed luminaires achieve this effect.

Penthouse in the Clouds



Patio . . .

To the owners, this house was the home of their dreams. They had leased the roof of an apartment hotel, and were constructing not merely a penthouse, but their home, just as one might plan to build in a regular plot of land.

To complement their beautiful design, they wanted lighting which would be an integral part of the structure. It had to enhance the coloring, texture, and beauty of the furnishings; accent certain appointments; in no way detract from the overall treatment which the owner, architect and decorator had in mind; and at the same time be in keeping with good lighting practice. All this, however, had to conform to a completed structure. Construction was well away before the lighting consultant was brought into the plan.

To say the least, there is considerable challenge or at least a "most interesting" element, in developing lighting techniques and finding equipment for specified lighting effects, with no structural changes possible.

The living room, one glimpse of which is shown here, contained several prized possessions, for which special effects were desired. General lighting in this room is from two 150-watt incandescent baffled recessed units, and a cornice over the draperies. The cornice contains a continuous row of deluxe warm white slimline lamps, three 8-foot units and one 4-foot unit. Bookshelves are "picked up" by illumination from two 150-watt recessed incandescent reflector lamps in an adjustable socket, directed toward a vertical movable reflector opposite the lamp within the same housing. An unusual table, a family heirloom, in front of the draperies, becomes a focal point by lighting from a 100-watt bayonet base lamp in a recessed unit equipped with an adjustable lens.

The portrait received special treatment. This has

Edna P. Fortier
New Orleans Section
South Central Region

Mrs. Fortier is Lighting Consultant with the Electrical Supply Co., New Orleans, La.

FIRST PRIZE
CLASS I

Living room . . .

been most effectively highlighted by two 75-watt incandescent tubular lamps concealed behind an urn which is always on the cabinet in front of the picture. In the photograph, the urn has been removed to reveal the source, but in practice the effect of this technique is a major decorative success. A diffusing glass distributes the light over the face of the portrait, softening the brush strokes. Lighting the picture from below directs annoying reflections to the ceiling, instead of into the eyes of the viewer.

One illustration of what was required to highlight an effect created by the architect is shown in the picture of the foyer. Here the decorative element was a hand-painted mirrored wall. The recessed lighting unit providing the highlighting is again, as with the bookshelves, an incandescent reflector lamp in an adjustable socket directed toward a vertical movable reflector opposite the lamp within the same housing. Light from this reflector is directed to the hand-painted scene. General light is from three recessed incandescent baffled 150-watt units.

Though not all shown in photographs, many such special effects were part of the interior design, with lighting insuring their achievement. The powder room adjacent to the foyer, for example, has a surface crystal basket type fixture mounted on a

Foyer . . .

mirrored ceiling. This unit has a matte finished plate to eliminate specular reflection. This type of fixture was selected primarily for effect, but with its three 60-watt inside frosted incandescent lamps, it provides quite adequate general lighting for the room. A cornice, with two single 40-watt deluxe warm white lamps provides 15 footcandles on the dressing table, and 30 on the face.

Another example of light for seeing, and lighting for effect was the den (not shown). Here the general lighting is from three 40-watt deluxe warm white fluorescent lamps in cornices over the window and sliding glass doors. Varying levels of illumination for the different visual tasks involved are provided by a baffled 150-watt incandescent recessed fixture controlled by a dimmer.

For the bar (see picture) colored lighting and a translucent figured plastic wall bring this out as a center of attention. A section of plastic wall impregnated with leaves and butterflies serves as a golden glowing background for the preparation and mixing of refreshments. Two 40-watt yellow fluorescent lamps, with two 20-watt deluxe warm white lamps behind the plastic wall create this effect. Additional light on the bar counter is provided by two 40-watt deluxe warm white lamps, recessed above, behind a plastic louver.

Pictures are not here available of the kitchen, but here too, recommended levels team with decorative treatment. Four recessed troffers were used, each with two 40-watt slimline deluxe cool white lamps, to form a rectangular pattern on the ceiling. They provide, as well, 80 footcandles. Sink and range areas are each illuminated by 150-watt incandescent louvered recessed fixtures. Light colored walls, floors and ceilings combine with the low brightness of the ceiling lighting fixtures to produce a glare-free well-lighted room. Illumination readings at the sink and range, with all lights on, are 100 footcandles.

There are two out-door living areas. The patio, (shown in the picture) which is accessible from the den, is lighted from pool and garden lights. Two standing portable units equipped with 150-watt incandescent lamps light corners of the patio, and mushroom shaped portable garden units bring out the color and beauty of the flowers and foliage in the planting area. There is even a pool in this unusual apartment. Five 150-watt incandescent underwater lights recessed in the side of the pool provide the silhouetting background for the flowers and lily pads which float on the water. A shimmering effect is created when the breezes ripple the pool's surface.

In this picture also can be seen one breathtaking effect not created by either the architect or the lighting consultant—downtown New Orleans glowing in the dusk. In all other areas, however, decorative design has been teamed in a happy combination with lighting to bring out the warmth, cheerfulness and beauty which the owners dreamed they would have, and did, in their penthouse in the clouds.

Colored lighting and translucent figured plastic wall in Bar area.

Members of the University of Michigan swimming team demonstrate a competition start under the high-level lighting at their

Exhibition Pool

SECOND PRIZE
CLASS II

Lawrence T. Genise
Michigan Section
Great Lakes Region

Mr. Genise is an electrical engineer with Giffels & Vallet, West Dearborn, Mich.

FOUR conditions were set down in the specification of quantity and quality of lighting at the University of Michigan's exhibition swimming pool. The project, under the direction of the Board in Control of Intercollegiate Athletics, contains facilities for intercollegiate swimming and diving competitions and exhibitions, with seating for two thousand spectators. The lighting system was required to provide:

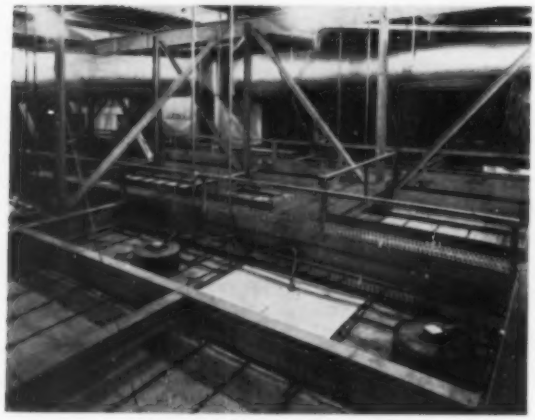
(1) good visibility for judges and spectators, without objectionable glare;

(2) adequate levels of illumination for television and motion picture photography of exhibition and competition meets;

(3) economic operation for practice sessions;

(4) perhaps most important, a quality of lighting which would not distract the swimmers and divers themselves.

Need for a dual lighting system was indicated: a combination of fluorescent for general lighting at practice sessions, increased by high-level incandescent for exhibitions. Underwater lighting was ruled out after consultation with swimmers, who felt that objectionable glare would prevent them from accurately judging the turns, thus slowing



Maintenance is from the lighted plenum, which has catwalks within easy reach of the fixtures. Incandescent units are painted black to help dissipate heat.

them, and that swimmers on outside lanes would be handicapped.

The pool area consists of a diving pool, 14 feet deep, and a racing pool varying from five to six feet in depth. Ceiling height over the pool surface is 35 feet.

With the type of lighting selected, the next step was to integrate it with the ceiling construction. The ceiling is of corrugated and aluminum material with a matte white finish, suspended on aluminum T-rails, which also completely frame and support the adjacent lighting fixtures. These T-rails could not be spaced over six feet apart. Because of these structural problems and other, aesthetic reasons, a four-foot-square fluorescent unit was chosen.

The fluorescent unit selected is a special fixture using ten 4-foot T-12 rapid-start cool white lamps, and is arranged for top servicing. Fixture surfaces that are exposed to the pool area are of aluminum. All metal portions of the unit are copperized to prevent corrosion from chlorine vapor and moisture, and the lens frame is gasketed to prevent the passage of moisture from the pool area into the plenum above. The dished plastic is of molded acrylic in two-foot-square panels.

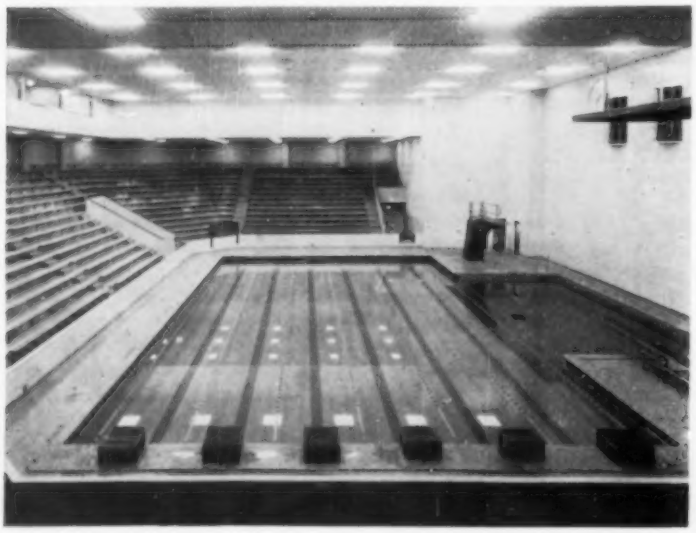
Similar square units, with four 20-watt trigger-start lamps, are used over the spectator seating area. These are bottom serviced. Some incandescent units on emergency circuit are also located here.

Supplementing this fluorescent system is the incandescent, using 1000-watt lamps in mirrored glass reflector units. Again, the heat-resistant glass roundel is gasketed to prevent moisture movement into the plenum and the unit has been treated to resist corrosion. It is also arranged for top servicing, and the exterior is painted black to dissipate heat. The major portion of the incandescent system is over the pool area.

The dual system is used, with a total of 85 footcandles, for exhibitions and competitions, for television and motion picture photography. For practice or other purposes, the fluorescent lighting alone supplies 30 footcandles. Room interior reflectances have been carefully chosen for comfortable brightness ratios.

Maintenance is from the lighted plenum, which has catwalks within easy reach of the fixtures.

Comments by swimmers and coaches and movies of actual swimming and diving in the pool under the lighting installation attest to its success in meeting its objectives.



Fluorescent lighting system alone supplies 30 footcandles for practice sessions.

For happy ending, see the following two pages.

A Case for Rehabilitation

THERE ARE other horror pictures, like the one above, for other areas of this house with a "lost week-end," sponsored by the *Cleveland Plain Dealer* and *Home Modernizing* magazine for rehabilitation instead of destruction. But this example should suffice to show what met the eyes of those selected to accomplish the transformation.

George Matilo
Cleveland Section
Great Lakes Region

Mr. Matilo is with the Residential Lighting Department, General Electric Co., Cleveland, Ohio.

The project, a part of "Operation Demonstrate," was kicked off by the *Cleveland Plain Dealer's* contest for school children to come up with the most plausible design for modernizing. A 16-year-old student in Loraine, Ohio, was the winner and the project developed from there.

Mr. Trevor Guy, member of AIA, was the architect appointed, and Miss June Nelson, from the Cleveland Fashion League, was the interior decorator. Squires Construction Co. was the owner-contractor and Morgan Electric Co. executed the ideas for lighting design developed by Miss Aileen Page and Mr. George Matilo of the General Electric Co.

The 50-year-old home, in a transitional neighborhood on the southeast side of Cleveland, was rehabilitated with very few structural changes. The front porch was removed, a new bay window added, several windows and doors were changed and relocated and a solid wall between kitchen and dining room was converted into a pass-through. Otherwise, the metamorphosis was accomplished by decoration and lighting. The photographs on the following pages show how the rehabilitation has turned an eyesore into a comfortable attractive home.

It is of interest that the builder sold this home, which had been purchased for $6000, for over $18,500.

The Rehabilitated Home

SECOND PRIZE CLASS I

Living Room—A cornice is used on one wall to make the room appear larger. Since the builder planned on salvaging as much of the original plaster as possible, light was deliberately kept off the ceiling. Portable lamps are used for reading and general illumination, and help to provide uniformity in lighting the wall. The bay window, added to the front of the house is lighted by three recessed units for vertical illumination on the draperies and 40 footcandles at the game table in the bay. General illumination level from cornice and portable lamps is 87 footcandles.

Bedrooms—General illumination in the small bedrooms is by conventional ceiling fixtures housing four lamps. With the pin-to-wall lamp in the room at left a person reading in bed will have 40 footcandles on his reading matter. A full-length mirror, not shown, is lighted by a surface mounted unit. In another bedroom, shown at right, a corner wall bracket provides 25 footcandles for reading.

Dining Room — The china cabinet wall is a continuation of the living room wall with cornice. Originally a soffit was planned, but the interior decorator wished to have a tall cabinet in this location. A valance lights the rear window, and a double-switched ceiling fixture supplies general lighting.

Kitchen — Since all the work activities in the kitchen are done at the perimeter, a valance, controlled from one electrical outlet, covers three walls of the soffit. The valance fascia board is mounted on commercially available brackets and small-cell plastic louvers provide shielding. The snack bar is lighted by a wall bracket papered to match the wall. A total of over 100 footcandles is provided.

Family and Sewing Room — Lighting in this finished third-floor area is by a continuous row of five 40-watt fluorescent lamps, shielded by a translucent plastic diffuser. The 25 footcandles supplied by this unit is supplemented by pin-to-wall lamps. At the sewing machine, not shown, there are 80 footcandles and for hand sewing 50 footcandles.

Living and Lighting . . . Adapted to the Pacific Northwest

THIRD PRIZE
CLASS I

Jack T. Cottingham
Oregon Section
Pacific Northwest
Region

Mr. Cottingham, who worked with architect, Walter A. Gordon, A.I.A., of Portland, on this installation is with the Portland General Electric Co., Portland, Ore.

FROM THE beginning, and no doubt contributing to the happy ending, lighting effects for this Oregon home were coordinated with the architect's plans for its character, purpose and decor. Numerous consultations were held in order to arrive at complete rapport with his desires.

Built as a demonstration for electrical living, the home was also designed to conform to typical needs and tastes of family life in the Northwest. The architect's plan for its general character was simplicity, with no straining for effect; the provision of a background for pleasant informal living. Careful studies were made, in the lighting design, to preserve this idea. Without resorting to custom made, expensive, or showy equipment, a lighting installation was planned with careful consideration for both the esthetic and utilitarian aspects of light and lighting, and the role each plays in contemporary living. All items were selected from a standpoint of both cost and availability; equipment is in the moderate price range, readily available from a number of manufacturers, and has been installed with an eye to control and flexibility for multi-purpose.

Although not visible in this daytime photograph (see picture) extensive use of lighting equipment outside the house allows expanded use of the outdoor living areas such as terrace, porches, and yard. Safety for the occupants is provided by surface-mounted floodlights located to cover the entire yard and controlled from various points inside the house. A total of 12 projector floodlamps and 11 individual recessed lens boxes are permanently installed on the exterior, and in addition, mushroom lights, hooded shrub and tulip lights are a part of the summer yard lighting.

Sunshine room provides freedom from tyranny by the weatherman, predicting more cloudy days.

Both incandescent and fluorescent sources have been used in valances in this home. Enhancement of various draperies has influenced the choice. In a family room such as was designed for this house (see picture), it is difficult to know where the housewife will place her dining table. A flexible traverse rod pull-down unit has been used to minimize this problem. This fixture, incidentally, is the only unit which might be considered above moderate cost. All others are standard fixtures adapted to the installation.

In addition to valance lighting on all draperies, general lighting in the living room and activity room is provided by a series of recessed dropped glass units with 100-watt incandescent lamps, in the lower portion of the ceiling. This allows maximum use of the available ceiling height, and by controlling with a wall box type auto-transformer dimmer, a wide variety of lighting levels suitable to mood or activity, is available. The window valance in this room uses a 12-inch-wide board across the top of the draperies, to conceal three 4-foot 40-watt and one 2-foot 20-watt deluxe warm white fluorescent lamps mounted on economy channels. The open top permits light to reach the ceiling, contributing to the general lighting. Portable lamps not visible in the photograph include a low Swedish Brass stand lamp for the bridge table. This uses two 100-watt white bulbs shielded and concealed by a metal plate and shaded by a white fabric barrel-shaped shade. Two tall table lamps are used near the side wall having brass bases and barrel-shaped white shantung translucent shades. Each has the wide harp to accommodate the R-40 white indirect three-way lamp. One tall table lamp has an orange ceramic base, a cast glass diffuser bowl and barrel-shaped white shantung translucent shade. This too uses the three-way 50/100/150-watt white lamp.

In the kitchen (not shown) general lighting is from a large area 2-foot by 4-foot recessed plastic faced fluorescent unit using two 40-watt deluxe warm white rapid start lamps. This is supplemented by sink lighting, two recessed units using 60-watt incandescent lamps, and work counter illumination, from 15-watt and 20-watt fluorescent lamps mounted on economy channels. These are shielded by the dropped edge of the cupboard and by white Plexiglas. The cooking surface is illuminated by three 60-watt IF lamps mounted in the copper-finished combination vent fan, filter and lighting fixture type hood. In this room also, deodorization is provided by a copper-finished decorative-type ozone generator. This is mounted above eye level for safety, and is operated continuously.

Sunshine Room

The cloudy climate of the Pacific Northwest inspired the design, for this home, of a "sunshine room." A survey of the past 10 years of cloud conditions in Portland showed an average of 300 overcast days per year, making such an installation not only practical but a welcome additional use of light for living in the Pacific Northwest.

Ceiling installation of both sunlamps and infrared lamps has created a permanent "sunshine" environment. For ultraviolet in the 3000 Angstrom range, there are three 275-watt RS-40 sunlamps, two in ceiling recessed high-hat units, one in an adjustable suspended hooded pull-down unit on a timer, over the lounge. Two infrared heat lamps for each sunlamp provide a balanced quantity of infrared and ultraviolet radiation, allowing children as well as adults to remain comfortable without body heat loss, even when very lightly clad. The infrared lamps, 250-watt R-40, are also ceiling mounted in "high-hat" units. Use of the deluxe infrared lamps with its red cap is optional where less visible light is desired.

In planning this installation, numerous conferences were held with doctors at the University of Oregon Medical School, in order that intensities, exposure times, and distance of sources from the skin, would insure proper hygienic and cosmetic results. Careful spacing and timer controls allow maximum utilization of the widely separated wavelengths of the two sources.

This home appears at its best at night, when the family is together and lights and lighting provide the background for pleasant informal living. Here the sunshine has literally been brought inside.

THIRD PRIZE
CLASS II

Lighting Aids for

Atmosphere in a Restaurant

CONTINENTAL Restaurant, in Dallas, Texas, is the result of restaurateur Vick Clasi's desire for a "plush" restaurant to compete with the best. Requirements for the lighting system were:

1. Flexibility in both illumination levels and arrangement, for various areas which could be used as private dining rooms, and at the same time an integrated system for use as one single room.
2. Decorative function to enhance the architectural design and modern decor.
3. Adaptability to limited installation space.
4. Ease and economy of maintenance.

The restaurant has three main dining areas, each with a different ceiling height: a high-bay section, an intermediate height ceiling under the balcony, and a low-ceiling area on the balcony. Recessed downlights in Alzak aluminum reflectors were chosen for general illumination in the three areas, with even distribution of light obtained by the placement and spacing of the units, the adjustment of the variable reflectors and the use of dimmers. Each area has its own dimming controls. Additional general illumination is provided by coves.

Accent lighting begins at a focal point, the copper hood. Special fixtures are mounted at various heights in circular deployment, and reflections from the copper hood to the ceiling add a further decorative touch. To provide light on the working plane beneath the hood, heat-resistant lamps are installed inside, which are able to withstand the temperatures created by the forced draft beneath and above the charcoal broiler.

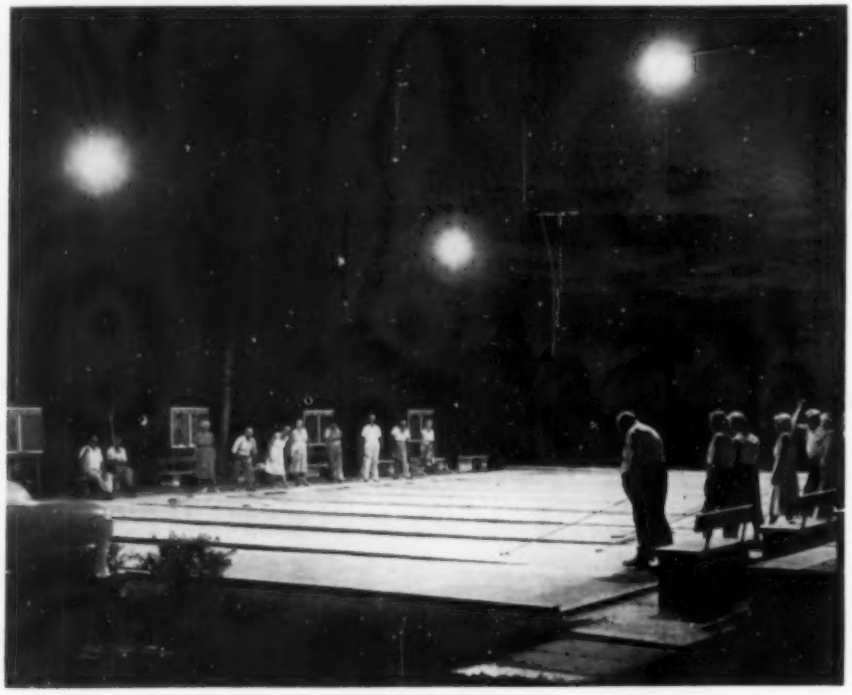
The decorative glass mosaic tile, imported from Mexico, furnishes an architectural and design element of the decor, with its curving lines and interesting colors and texture highlighted by accent lighting. By careful positioning of the units in the limited space, the desired distribution of light on walls and dining areas has been achieved.

Other decorative lighting techniques are: special custom-built fixtures on the winding staircase; green reflectors placed in recessed units over the potted plants; special lighting in the refrigerated cases, wine cooler, pie cases, cigar cases and open displays.

The shallow units satisfied the requirement of limited space, and the Alzak reflectors and 100-watt incandescent lamps used fill the need for ease and economy of maintenance.

Earl I. Dinsmore
North Texas Section
Southwestern Region

Mr. Dinsmore is Regional Sales Manager, Curtis Lighting, Inc., Dallas, Texas.



INSTALLATION AT TRAILER ESTATES, U. S. HIGHWAY 41
MANATEE COUNTY, FLA.

Lighting a Shuffleboard Court

LIGHTING OBJECTIVE: To provide uniform illumination on an outdoor shuffleboard court for nighttime use.

GENERAL INFORMATION: Playing time has been extended several hours each day on the above ten courts which measure 40 feet by 80 feet. The court playing surface is cement having a 21 per cent reflectance.

INSTALLATION: Two General Electric mercury vapor luminaires, Model No. 2F400A1 (I.E.S. Type IV distribution), are installed on each side of the courts on approximately 40-foot centers and at a 20-foot height. Each luminaire, which is mounted on a No. A5G173 bracket, utilizes one H400-J1 color improved mercury vapor lamp operating from a catalog No. 89G298 weatherproof high power factor ballast.

The average level of illumination after one year's operation was 7 footcandles.

With this new lighting installation, shuffleboard took a tremendous jump in popularity at Trailer Estates.

Lighting designed by Si Bell, President of Sarasota Electric Corp., 1021 Central Ave., Sarasota, Fla.

Lighting data submitted by Si Bell, as an illustration of good lighting practice and to aid in the design of similar installations.

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A Study of the Extraction of Heat from Fluorescent Luminaires in Air Cooled Rooms

By WALTER STURROCK and LESTER F. SCHUTRUM

FOR MANY years the universal method of cooling rooms and buildings for comfort during the summer months has been to introduce cool air through an air distribution system. More recently other schemes have been used which include panel cooling and cold water circulating systems. It has of course always been recognized that the energy load required for electric lighting is a heat factor which must be considered in designing these systems. Fig. 1 shows the approximate degree to which the designed capacity of the cooling system has been affected by the lighting load as installed in practice in three general types of interior occupancy.* The following is a study of the dissipation of energy from fluorescent lighting luminaires by air ventilating systems and by ceiling panels.

Equipment

A test room 12 feet wide and 24 feet long with a 10-foot ceiling was designed by the technical staff of the American Society of Heating and Air Conditioning Engineers (ASHAE) and installed in their laboratory, Cleveland, Ohio. The four walls, the floor and the ceiling were internally equipped with a liquid distribution system which could be controlled for heating or cooling as desired. Thermocouples, one for each four square feet of area, for surface temperature measurements were installed in each of the six room surfaces and were connected so that integrated values could be recorded separately for each surface. Since this study required a good present-day level of illumination, it was decided to install about six watts per square foot in fluorescent RLM standard luminaires each employing three 40-watt lamps which would direct all the light downward. The same luminaires were inverted to direct all the light upward. Figs. 2 and 3 show the room dimensions and lighting layout plan.

Illumination measurements made shortly after the luminaires had been operated for 100 hours indicated an average of 181 footcandles for the direct lighting system and 82 footcandles for the indirect system. These initial levels of illumination when obtained from commercial installations under usual service and maintenance conditions would

*From Table I. Artificial Lighting and Its Relation to Air Conditioning by Walter Sturrock, Heating and Ventilating, January 1953.

A paper presented at the National Technical Conference of the Illuminating Engineering Society, September 9-13, 1957, Atlanta, Ga. AUTHORS: Lamp Division of General Electric Co., Nela Park, Cleveland, Ohio; American Society of Heating and Air Conditioning Engineers, Laboratory, Cleveland, Ohio, respectively. This paper approved by the Papers Committee of I.E.S. as a Transaction of the Illuminating Engineering Society.

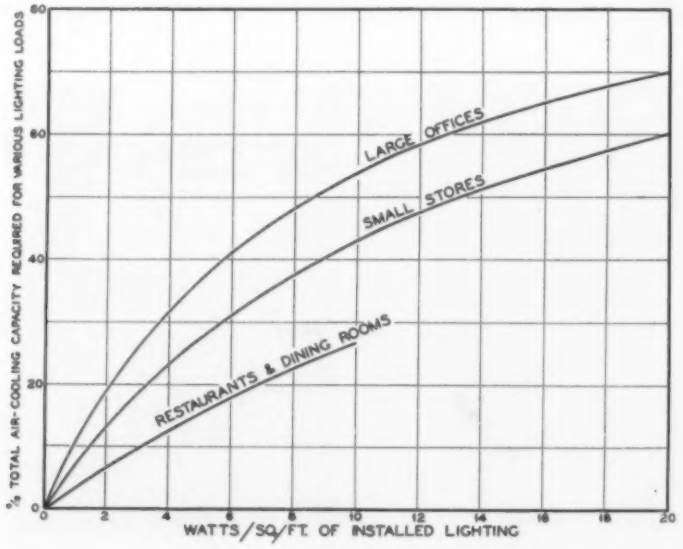


Figure 1. Effect of lighting load on air-cooling capacity.

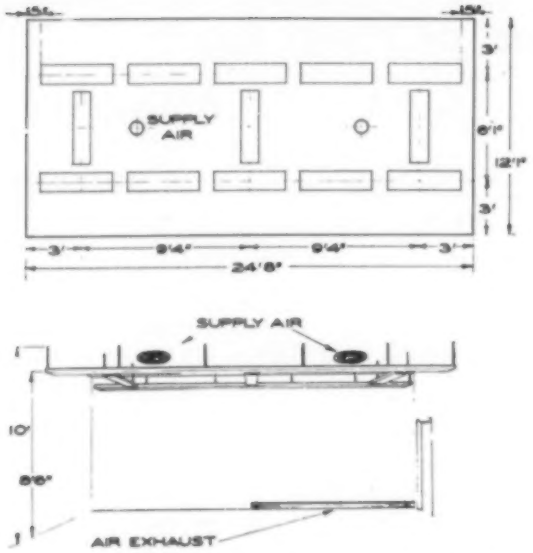


Figure 2. Test room dimensions and lighting plan.

over a period of time average not more than about 135 and 55 footcandles respectively.

Test Procedure

The test room was originally designed for a series of investigations all of which were related to the performance of ceiling panel heating and cooling. Most of the tests were made in an unlighted room and the results have been reported in two American Society of Heating and Air Conditioning technical papers.*

The following is a continuation of the series of investigations for which data have been obtained for a study of the dissipation of energy from fluorescent luminaires through ceiling panels. Since in the previous investigations most of the tests were made with five air changes per hour, it was decided to continue on this basis. However, as will be observed from Table III a few data were obtained for ten air changes per hour for comparison with five air changes when all other variables remained the same.

For all tests the luminaires were lighted for a minimum of two hours before recording data which by trial was found to be a sufficient length of time to stabilize the room temperatures. As previously mentioned, all the room surfaces were controlled for heating or cooling as desired which made it possible to have a comparable environment for all tests, by simply holding the temperature of the four walls, floor and ceiling at a constant value. The normal emissivity of the room surfaces was .92. The voltage of the electric circuit was held at a constant value of 118 by use of a variable autotransformer.

The total watts input for the electric system varied somewhat under different room and lighting conditions and therefore watt meter readings were recorded (and the equivalent BTU/hr) for each test.

It was assumed at the outset that for a given number of air changes per hour the relative amount of heat removed from luminaires by ceiling panels and by a ventilating air system would depend largely upon their maintained temperatures. With this assumption the following studies were made in analyzing the dissipation of energy from a direct and an indirect fluorescent lighting system employing luminaires of the RLM three-40-watt lamp type.

*See ASHAE Journal Section of *Heating, Piping and Air Conditioning*, November 1957.

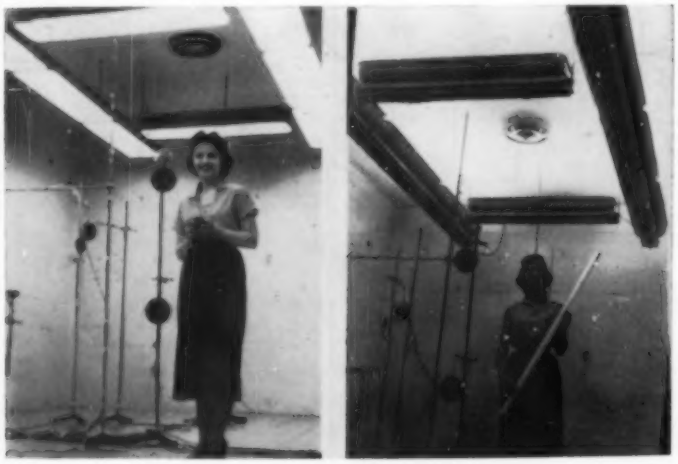


Figure 3. View of the direct and indirect fluorescent installations. Supply air enters room in center of ceiling.

TABLE Ia — Effect of Change in Ceiling Panel Temperature With Five Changes Per Hour of 60° F Supply Air.

Direct Luminaires	Supply Air Temp. °F	Ceiling Temp. °F	Walls and Floor Temp. °F	Room Air Temp.* °F	Bulb Wall Temp. °F	BTU/Hr Added to Room				BTU/Hr Removed from Room			Unbalanced
						Luminaire	Floor	Walls	Total	Ceiling	Air	Total	
AD	60.1	65.1	79.9	74.3	123.2	6064	1036	2635	9.35	6609 64.5%	3636 35.5%	10245	510 5.1%
BD	60.3	69.9	79.9	75.8	124.9	6150	710	1200	8060	4435 52%	4098 48%	8533	473 5.7%
CD	60.0	85.5	80.1	80.1	128.2	6081	1480**	2486**	9241	3160***	5126 56.2%	9092	149 1.6%
Indirect Luminaires													
AI	59.3	65.3	80.0	75.2	107.3	6325	1659	3502	11396	7135 63.2%	4138 36.8%	11273	123 1.1%
BI	60.2	70.2	79.6	76.4	110.6	6467	874	1928	9269	5118 53.3%	4479 46.7%	9597	328 3.5%
CI	59.8	84.9	80.0	80.4	115.7	6317	833**	2006**	8416	2099***	5585 66.3%	8424	8 .1%

*At 5 ft above floor.
**Heat removed.
***Heat added.

TABLE Ib — Analysis of Data from Table Ia Showing Relative Amounts of Light Source Radiant Energy Absorbed by Ceiling Panels from Direct and Indirect Fluorescent Luminaires. Supply Air 60° F — Ceiling Panels 65° (Test A), 70° (Test B), and 85° F (Test C).

Tests	BTU Per Hour Generated by Luminaires "H_1"	BTU/Hr Removed				BTU/Hr of Radiant Energy Absorbed by Ceiling Panels				
		Radiation			Convection	Light Energy	Low Temp. Rad.	Total "H_3"	Per Cent of BTU Generated H_3/H_1	Per Cent of BTU Removed H_3/H_2
		Light Energy	Low Temp. Rad.	Total "H_2"						
Direct Luminaires										
AD	6064	585 9.6%	1923 31.7%	2508 41.3%	3556 58.7%	17	1015	1032	17.0	41.1
BD	6150	582 9.5%	1960 31.9%	2542 41.4%	3608 58.6%	17	938	955	15.5	37.5
CD	6081	572 9.4%	1979 32.5%	2551 41.9%	3536 58.1%	17	508	525	8.6	20.6
Indirect Luminaires										
AI	6325	619 9.8%	1305 20.6%	1924 30.4%	4401 69.6%	316	942	1258	19.9	65.3
BI	6467	616 9.5%	1393 21.5%	2009 31.0%	4458 69.0%	315	867	1182	18.3	58.7
CI	6317	607 9.6%	1216 19.2%	1823 28.8%	4494 71.2%	310	526	836	13.2	45.8

Test No. 1

With the supply air at 60 degrees F and ceiling panel temperatures of 65, 70 and 85 degrees F, observations were made with five air changes per hour. (See Table Ia.)

Test No. 2

With ceiling panel temperatures held constant at 70 degrees F and supply air temperatures of 60, 70 and 75 degrees F, observations were made with five air changes per hour. (See Table IIa.)

Test No. 3

With the ceiling panel temperatures at 70 degrees F and supply air at 60 degrees F, observations were made with ten room air changes per hour. (See Table III.)

Computations

Low Temperature Radiation

Table IV shows a polar coordinate distribution curve of low temperature radiation from the test fluorescent luminaire, superimposed on its candlepower distribution curve. The low temperature radiation values were observed by use of a radiometer three feet from the luminaire in a room having all surfaces controlled at a uniform temperature. The meter was calibrated to indicate BTU per hour. The meter readings multiplied by the distance squared (3^2) gave the radiation intensity at various angles and by use of the usual zonal constants the total BTU per hour from the luminaire were obtained.

From the lighting plan there were five different

TABLE IIa — Effect of Change in Supply Air Temperature With Five Changes Per Hour When Ceiling Temperature Is Maintained at 70°F.

Direct Luminaires	Supply Air Temp. °F	Ceiling Temp. °F	Walls and Floor Temp. °F	Room Air Temp.* °F	Bulb Wall Temp. °F	BTU/Hr Added to Room				BTU/Hr Removed from Room			
						Luminaire	Walls	Floor	Total	Ceiling	Air	Total	Unbalanced
BD	60.3	69.9	79.9	75.8	124.9	6150	1200	710	8060	4435 52%	4098 48%	8532	473 5.7%
DD	69.9	70.1	80.0	77.6	126.3	6334	761	53	7148	5323 71%	2160 29%	7483	335 4.6%
ED	74.7	70.0	79.9	78.7	126.4	6261	417	201**	6678	5684 83%	975 14%	6860	182 2.7%
Indirect Luminaires													
BI	60.2	70.2	79.6	76.4	110.6	6467	1928	874	9269	5118 53.3%	4479 46.7%	9597	328 3.5%
DI	70.1	70.1	79.9	78.3	109.7	6357	1223	535	8111	6185 74.5%	2130 25.5%	8315	204 2.5%
EI	75.0	70.2	79.8	79.2	110.3	6300	518	424	7242	6725 91.2%	649 8.8%	7374	132 1.8%

*At 5 ft above floor.
**Heat removed.

TABLE IIb — Analysis of Data from Table IIa Showing Relative Amounts of Light Source Radiant Energy Absorbed by Ceiling Panels from Direct and Indirect Fluorescent Luminaires. Ceiling Panels 70°F — Supply Air at 60° (Test B), 70° (Test D) and 75°F (Test E).

Tests	BTU Per Hour Generated by Luminaires "H_1"	BTU/Hr Removed				BTU/Hr of Radiant Energy Absorbed by Ceiling Panels				
		Radiation			Convection	Light Energy	Low Temp. Rad.	Total "H_2"	Per Cent of BTU Generated H_2/H_1	Per Cent of BTU Removed H_2/H_2
		Light Energy	Low Temp. Rad.	Total "H_2"						
Direct Luminaires										
BD	6150	582 9.5%	1960 31.9%	2542 41.4%	3608 58.6%	17	938	955	15.5	37.5
DD	6334	578 9.1%	2048 32.4%	2626 41.5%	3708 58.5%	17	966	983	15.5	37.4
ED	6261	578 9.2%	2170 34.7%	2748 43.9%	3513 56.1%	17	1024	1041	16.6	37.9
Indirect Luminaires										
BI	6467	616 9.5%	1393 21.5%	2009 31.0%	4458 69.0%	315	867	1182	18.3	58.7
DI	6357	617 9.7%	1344 21.1%	1961 30.8%	4395 69.2%	315	861	1176	18.5	59.9
EI	6300	616 9.8%	1259 20.0%	1875 29.8%	4425 70.2%	315	877	1192	18.9	63.5

TABLE III — Relative Data for Five and Ten Air Changes Per Hour. Supply Air 60°F, Ceiling Panels 70°F, Sidewalls and Floor 80°F. Test "B" — Five Changes Per Hour; Test "F" — Ten Changes Per Hour.

Tests	BTU Per Hour Generated by Luminaires "H_1"	BTU/Hr Removed				BTU/Hr of Radiant Energy Absorbed by Ceiling Panels				
		Radiation			Convection	Light Energy	Low Temp. Rad.	Total "H_2"	Per Cent of BTU Generated H_2/H_1	Per Cent of BTU Removed H_2/H_2
		Light Energy	Low Temp. Rad.	Total "H_2"						
Direct Luminaires										
BD	6150	582 9.5%	1960 31.9%	2542 41.4%	3608 58.6%	17	938	955	15.5	37.5
FD	6355	595 9.4%	1541 24.3%	2136 33.7%	4219 66.3%	17	753	770	12.1	36.0
Indirect Luminaires										
BI	6467	616 9.5%	1393 21.5%	2009 31.0%	4458 69.0%	315	867	1182	18.3	58.7
FI	6399	620 9.7%	948 14.8%	1568 24.5%	4831 75.5%	316	740	1056	16.5	67.3

TABLE IV — Candlepower and Radiant Energy Distribution of RLM 3-40-Watt Lamp, 48" Closed End Porcelain Enameled Fluorescent Unit.

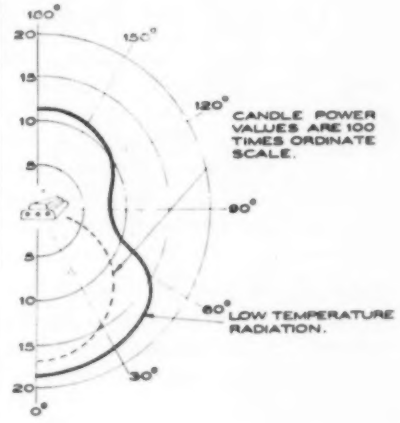
Luminaire Distribution Data

Mean Vertical

Mid Zone Angles	Light		Low Temp. Radiation	
	Candlepower at 25 Feet	Zonal Lumens	Radiation at 3 Feet	Zonal Heat Flow BTU/Hr
180			11.3	
175			11.3	1.13
165			11.3	3.15
155			11.3	6.20
145			11.2	7.07
135			10.8	8.30
125			10.2	9.18
115			9.0	8.94
105			8.0	8.40
95			7.8	8.53
85	26.3	38	8.4	9.12
75	246	260	9.5	10.08
65	660	655	12.4	12.32
55	1030	924	16.0	14.44
45	1290	998	17.2	13.26
35	1460	917	17.6	11.11
25	1590	736	17.7	8.17
15	1680	475	17.9	5.01
5	1710	162	18.2	1.82
0	1720		18.2	

3-40-Watt Fluorescent Lamps
6900 Lumens — 472 BTU/Hr (Still Air 71.5° F)

Zone	Light		Low Temp. Radiation	
	Lumens	Per Cent	BTU/Hr	Per Cent
0-90	5165	75.0	85.33	18.1
90-180			59.90	12.7
0-180	5165	75.0	145.23	30.8



positions of luminaires with respect to ceiling and side walls. By a laborious method the BTU of radiant energy — in angles directed toward the ceiling, side walls and floor — were computed for each of the five positions and when properly weighted and summarized the overall value was obtained for a uniform temperature environment.

For the various test conditions where each room surface and the luminaires were all at different temperatures, the radiation transferred from the luminaire to each room surface was computed proportionally to the difference of the fourth power of their absolute temperatures. (See Thermal Radiation Equation, page 92, ASHAE 1956 Guide.)

Visible Energy Absorbed by Ceiling Panels

The visible energy absorbed by all room surfaces was observed from their Heat Flow meters* by noting the difference in readings between "Lights On" and "Lights Off." In other words after the lights had been on for some time readings were observed for the meters located in the ceiling, walls and floor, after which the lights were turned off and similar readings immediately recorded. From these readings it was found that the ceiling absorbed 3 per cent of the visible energy from the direct fluorescent luminaires and 51 per cent from indirect.

Bulb Wall Lamp Temperatures and Light Energy

Fig. 4** shows the relation between bulb wall lamp temperatures and per cent light energy output. In order to have a common basis for analyzing and comparing the data the bulb wall lamp temperature was observed in each test as shown in Tables Ia and IIa and from Fig. 4 the corresponding per cent light energy output was obtained. The 100 per cent output value was found by the "Lights On – Lights Off" method as explained above. The reading for direct luminaires was 592 BTU per hour with a bulb wall temperature of 120 degrees F and since the curve indicates that this is 95 per cent output; the maximum value is 623 BTU per hour. This value was checked for the indirect system when the bulb wall temperature was 112 degrees F. The BTU per hour observed were then 612 which the curve shows is 98 per cent of the maximum.

Total Energy from Fluorescent Luminaire

The watts consumed by the lighting system (including auxiliaries) were expressed as BTU per hour by using the accepted multiplier factor of 3.413. The products are shown in Tables Ia, IIa, and III under the caption of BTU added to room by luminaire. The low temperature radiant energy plus the light energy was subtracted from the total luminaire BTU to obtain the convected heat. The computed values of convected heat from the luminaire were checked and balanced against data obtained from heat flow meters which utilized about

*For design details, see *Heating, Piping and Air Conditioning*, May 1952.

**From G. E. Lamp Bulletin LD-1 for 40-watt fluorescent lamps.

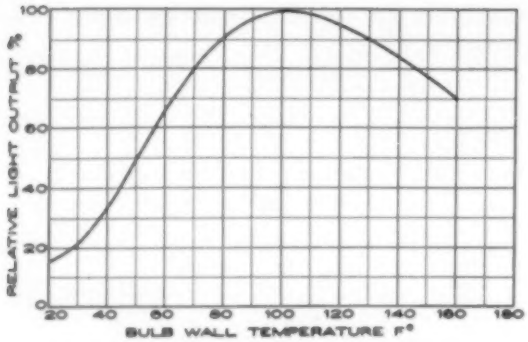


Figure 4. Effects of bulb wall temperature on fluorescent lamp light output.

10 per cent of all room surfaces. By this method the degree of possible error in the overall heat balance was determined and is shown in the last column of Tables Ia and IIa.

Conclusions

1. About 9.5 per cent of the energy generated by a three-40-watt fluorescent luminaire including auxiliaries is in the form of visible energy which will be absorbed by the room surfaces. (See Table Ib and IIb.)

2. With five air changes per hour the radiant energy removed from direct fluorescent luminaires is about 42 per cent of the total energy generated by them. The corresponding value for indirect units is about 30 per cent. (See Tables Ib and IIb.) The temperature of the ceiling or supply air made no appreciable difference in these readings. From Table III with ten air changes per hour these values are 34 per cent and 25 per cent respectively.

3. With five air changes per hour of 60 degrees supply air, ceiling panels at 70 degrees F will absorb about 15.5 per cent of the total BTU from direct fluorescent luminaires and about 18.3 per cent of the total energy from indirect luminaires. With ten air changes per hour these values become 12.1 per cent and 16.5 per cent respectively. (See Table III.)

Summary

Published data* on the conversion of energy from 40-watt white fluorescent lamps such as used in this test indicate that 54 per cent of the watts consumed are in the form of radiant energy which includes 16½ per cent in light. However, when three of these lamps with their auxiliaries are placed in an RLM totally direct type of luminaire the conversion of energy is considerably changed with the result that only about 9½ per cent is in light, while the amount of low temperature radiation varies depending to some extent on the nature of the candlepower distribution.

Many fluorescent lighting systems employ luminaires of the open bottom or louvered direct type and the tests indicate that about 42 per cent of the watts consumed by such units will be converted into radiant energy with about 58 per cent in convected heat. When these direct types of luminaires are built into a ventilated ceiling with glass or plastic bottom plates or are installed above a ventilated false ceiling it seems evident that the low temperature radiation and convected heat transferred into the room will be considerably less than obtained from luminaires suspended below the ceiling. This checks with data reported* by Mr. C. S. Leopold at the 1951 Annual Meeting of the ASHAE. He conceived the plan of installing some of the ceiling panel cooling coils on the back of a troffer-type luminaire (see Fig. 5), so that the luminaire itself became a cooling panel. He concluded that "the performance per unit area of such a panel is higher than a normal ceiling panel since much of the radiation as well as convected and conducted heat is directly intercepted before it warms other room surfaces or the room air." It seems logical to further conclude that fluorescent lighting systems of the so-called luminous ceiling design will have their energy most effectively dissipated if a cooling system either of circulating air or coils of cold water or a combination of them can be installed above the ceiling in a manner to remove heat before it enters the room. In fact, this is a necessity when the BTU from lighting is a major portion of the total heat and when the lighting load is so high in watts per square foot that the room cannot be comfortably cooled with a normal amount of circulating air.

*See G.E. Lamp Bulletin LD-1.

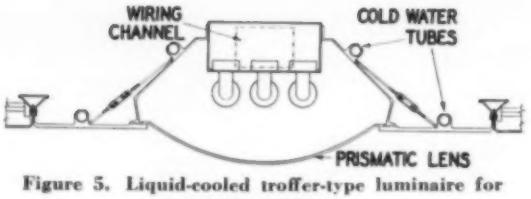


Figure 5. Liquid-cooled troffer-type luminaire for ceiling installation.

Acknowledgments

The authors wish to acknowledge with grateful appreciation the most helpful assistance of Mr. T. C. Min in making observations and analyzing the data. Also they wish to thank Mr. C. M. Humphreys for his consultation and advice and the American Society of Heating and Air Conditioning Engineers for their permission to publish this paper.

*Design Factors in Panel and Air Cooling Systems.

DISCUSSION

ROBERT W. MCKINLEY:* Those of us who have been privileged to participate in the affairs of both IES and ASHAE realize that we have many mutual interests and similarities beyond our efforts to evaluate and control the human environment. Cooperative work such as reported here is welcome evidence of a healthy relationship between two branches of the engineering profession.

Though I am certain that the specific data presented will prove most valuable to designers and result in more comfortable environments, I believe that this study will ultimately be recognized as even more important because of the underlying significance of the data. These figures suggest that better cooling systems and better light sources will be needed before we can push electric lighting levels much above 50 footcandles.

The authors indicate on page 574 that above a certain load level a room cannot be "comfortably cooled" with a "normal amount of circulating air." Is this because the radiant energy density to which the occupants are exposed exceeds a comfort-limit level? If so, what is this level? If not, what is the critical factor? Also, how would the lighting load limit level of an "air-only" system be influenced by other components of the total load? Do the authors agree that four watts per square foot (related to 90 footcandles of direct lighting or 37 footcandles of indirect lighting) is about the largest fluorescent lighting load that can be handled adequately by an air-only system operating at 5 changes per hour?

It seems to me that a similar study of an incandescent system is needed. Possibly the effective heating abilities of high level lighting systems should receive greater study by Heating Engineers as a means of winter heating.

E. H. SALTER:** Congratulations are surely in order for Messrs. Sturrock and Schutrum on the first solution to a long-standing problem and especially for the first distribution curve of low-temperature radiation about a lighting fixture. For some years the Joint Committee of IES and ASHAE on Lighting and Air Conditioning has been pleading for such information. It would appear that the tools now are available for obtaining such data for the various types of lighting fixtures used in air-conditioned spaces.

In connection with the distribution curve shown for low-temperature radiation about the lighting fixture, I note that these data were obtained with the receiver at a distance of three feet from the luminaire. It has been a general rule in photometry that the distance from the luminaire to the receiver should be not less than five times the maximum dimension of the luminaire. Would the authors consider that the three-foot distance used in this instance would be adequate?

HOWARD M. SHARP:† I am puzzled by some of the data disclosed by this experiment and would appreciate the opinions of the authors as to the possible reasons for the results.

(1) In Table Ib, why should the higher temperature ceiling panel absorb approximately 50 per cent less radiant heat from the direct system than the lower temperature panel, while for the indirect system the higher temperature panel absorbed approximately 30 per cent less radiant heat than the lower temperature panel? Yet Table Ib shows that the amount of radiant BTU's *removed* is approximately the same regardless of temperature of ceiling panel. Is there, perhaps, a differentiation in the experimental setup between radiant heat absorbed by the ceiling panels and radiant heat removed by them?

(2) In Table III, why should the increase in the number of air changes per hour decrease the percentage of generated BTU's absorbed by the ceiling panels? I can see why the total radiant BTU's will be reduced due to greater cooling of of the luminaires as a result of the increased number of air changes, but not why the efficacy of the ceiling panels should be reduced.

On the procedural side of the experiment, I have two questions:

(1) What is the explanation for the BTU's added to the room by walls and floor (Tables Ia and IIa)?

(2) Does "low temperature radiation" mean the radiation emitted by surfaces whose temperature does not exceed 500 degrees F? Are the room surfaces making any significant contribution to this low temperature radiation by virtue of absorption of light energy?

It is to be hoped that this laboratory setup will remain available for further experimentation, for it supplies us with a means for tracking down the elusive radiant heat component of lighting systems in terms of BTU's. It will also provide data as to room surface temperatures resulting from various light distributions, and mean radiant temperature, thus enabling a more precise evaluation of heat gain, heat distribution and comfort.

W. S. FISHER:* I am really pleased to see the results of this joint study in cooperation with the American Society of Heating and Air Conditioning Engineers. It certainly points out the possibilities for improvement in ceiling system design — for which there is a real need. It seems to be getting to the point that air conditioning is an overriding factor in establishing ceiling heights and determining lighting patterns in commercial buildings, to say nothing of its effect on building budgets.

For every dollar spent for lighting, about fifty cents must be added for the air conditioning to take care of it. Those are total cost figures, but since initial cost for air conditioning represents a higher proportion of total cost than lighting, it sometimes seems, on a first cost basis, as if air conditioning costs are almost equal to the lighting it takes care of.

In view of the remarkable achievements in improving fluorescent lamp efficiency over the past few years, one might say that this will solve the problem by permitting higher lighting levels to be installed without increasing air conditioning costs beyond present-day levels. But it seems as if contributions to efficiency can also be made with air conditioning systems, and, if done, this should improve the economics of building construction to the point that the higher lighting levels we know are desirable can be installed sooner and at lower cost.

The possibility for extracting a significant part of the heat energy from fluorescent fixtures before it enters the room is a scheme worthy of much more attention. Thanks to the authors for bringing this to our attention again and for giving us this valuable quantitative data.

WALTER STURROCK and L. F. SCHUTRUM:** Sufficient data

*Pittsburgh Plate Glass Co., Pittsburgh, Pa.
**Electrical Testing Laboratories, Inc., New York, N. Y.
†Consulting Engineer, Easton, Md.

*General Electric Co., Nela Park, Cleveland, Ohio.
**Authors.

are not available on specific air cooling systems to indicate the maximum lighting load level with its BTU equivalent which can readily be dissipated by a normal amount of circulating air. Mr. McKinley mentions radiant energy which in general is that part of the heat energy from high level lighting which most readily causes discomfort to the occupants of an air cooled room. The amount of radiant energy from lighting units designed for equal wattage light sources can vary widely depending upon the distribution of energy from each unit. The data in the paper, Table Ib, show that about 70 per cent of the total heat was removed by the air circulating system (convected heat) when totally indirect lighting was used while only about 58 per cent was removed for direct lighting. It is of course recognized that for direct lighting the remaining 42 per cent in the form of low temperature radiation could be so widely distributed that it in itself would probably not cause discomfort until it is absorbed and reradiated in the form of sensible heat. In this case the BTU equivalent for the total lighting load could probably be removed by convection and when those lighting load BTU plus the heat from other contributing sources become so great that they cannot be removed by a circulating air system without causing uncomfortable drafts other means of dispensing with the heat must be considered. Of course, one must also recognize the fact that some air cooling systems can satisfactorily use lower temperature air than other systems which makes it difficult to estimate the maximum amount of heat that can be dissipated by air cooling systems.

In reply to Mr. Salter's question about the three-foot distance which was used in getting low temperature radiation readings, the authors believe that a distance of five times the length of the luminaire would provide more accurate data. The radiometer used in this study, however, was not sufficiently sensitive to permit its use at the greater distance and also there were space limitations.

Mr. Sharp calls attention to the data in Table Ib which show that for direct lighting the 65-degree F ceiling absorbs 1032 BTU of radiant energy and the 85-degree F ceiling 525 BTU; the latter being about 50 per cent of the former. On the other hand for the indirect system the 65-degree F ceiling absorbs 1258 BTU and the 85-degree ceiling absorbs 836; the latter being nearly 70 per cent of the former. Since the temperature of the ceiling has no significant effect on these percentage figures, their difference appears to be due entirely to the distribution of the light energy striking the ceiling, which in the case of direct lighting is 17 BTU while for indirect it is about 315.

In reply to Mr. Sharp's question as to why the ten air changes per hour show a decrease over five air changes per hour in BTU absorbed by the ceiling, this is due to the fact that the greater amount of circulating air keeps the luminaire cooler and therefore reduces the amount of generated low temperature radiation and hence less to be absorbed by the ceiling.

As mentioned on page 570 under test procedure, the temperature of the four walls, the floor and the ceiling could be controlled as desired. For these tests in which the temperature of the walls and floor was maintained at a constant value higher than room temperature the heat flow meters indicated an inward flow of heat which the tables show as heat added to the room.

Mr. Sharp asks for a definition of low temperature radiation. On page 648 of September 1956 ILLUMINATING ENGINEERING, we find the following: "The dividing line between these two radiations (high and low temperature) is the wavelength between 4000 and 5000 millimicrons at which glass becomes completely opaque to radiation." Since a black body at 500 degrees F radiates most of its energy above this band in the spectrum one can consider in general that a surface below 500 degrees F emits its energy as low temperature radiation. In the test room having temperature controlled surfaces the absorption of light by the interior did not contribute to the amount of low temperature radiation which would of course be the case in an actual room.

Next Year's Conference Papers

Deadline for outlines of next year's conference papers will be December 31, 1957. The earlier date of the conference next year (August 17-22, 1958) has necessitated an earlier deadline for the Papers Committee consideration of proposed papers. Those wishing to present papers before the 1958 conference in Toronto should submit outlines of them, not later than December 31, 1957, to:

Mr. H. F. Davidson, Chairman, Papers Committee
Curtis Lighting of Canada, Ltd.
195 Wicksteed Ave.
Leaside, Toronto 17, Ont.

LIGHTING AT U. S. POST OFFICE, LAFAYETTE BLVD. AND SHELBY ST.
DETROIT, MICH.

Lighting Public Space in a Post Office

LIGHTING OBJECTIVE: To provide general illumination in the public space of a post office by a system incorporated into the architectural decor of the ceiling.

GENERAL INFORMATION: The architectural appearance of the ceiling (bronze and gold with light gray background — 50% RF) in the main corridor, shown above, and of the ceiling in one of the elevator lobbies, shown in Fig. 2, was not destroyed in the relighting of these spaces. The main corridor measures approximately 22 feet by 153 feet (nine 17 by 22-foot bays), and the elevator lobby measures 18 feet by 37 feet. The ceiling height varies from approximately 16 feet at the walls (warm color marble —30% RF) to 19½ feet at the center. The floors are travertine of 30% RF.

INSTALLATION: There are four Rambusch Downlites, catalog No. MEA-T (equipped with one 300-watt PS-30 incandescent filament lamp) recessed in each bay of the main corridor. The units in five alternate bays have a 15-degree tilt and are spaced on 6 by 17 foot centers. The units in the remaining four bays have a 10-degree tilt and are spaced on 6 by 13 foot centers. There is also 14 feet of fluorescent cove lighting on each side of each bay, consisting of one 96-inch and one 72-inch T-12 de luxe cool white slimline lamp.

(over)

A.I.A. File No. 31 f

Lighting Public Space in a Post Office (Continued)

There are eight Rambusch Downlites, catalog No. MEA-T, equipped as above, in the elevator lobby. These units, which have a 10-degree tilt, are recessed 10 feet on centers in two rows 8 feet apart. There are also two 36-foot coves, one along each of the longer walls. These are each equipped with four 96-inch and one 48-inch T-12 de luxe cool white slimline lamps.

The average level of illumination was approximately 13 footcandles after 500 hours' use. Brightnesses at that time were as follows:

ceiling, in middle	1.3 fL
over cove	15.0 fL
walls	1.2 fL
floor	3.5 fL
luminaires at 45°	4.3 fL

Figure 2. View of elevator lobby.

Lighting designed by Leonard H. Gussow, 1112 Charlevoix Building, Detroit, Mich.; Contractor: W. D. Gale Co., 7145 Tireman, Detroit, Mich.

Lighting data submitted by James F. Finn, The Detroit Edison Co., 2000 Second Ave., Detroit, Mich., as an illustration of good lighting practice and to aid in the design of similar installations.

Published by the Committee on Publications of the Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y.

Design and Characteristics of Fluorescent Lamps Having a Non-Circular Cross Section

By J. O. AICHER and E. LEMMERS

Introduction

FLUORESCENT LAMPS have been inherently low wattage devices. Attempts to increase light output without seriously reducing lamp efficiency have resulted in an increase in bulb diameter to a maximum of T17, an increase in length up to 96 inches, and, to some extent in an increase in operating current. For reasons of economy in number of fixtures required, and to permit higher levels of illumination to be obtained, still further increases in size of the "package of light" were desired. This paper describes how this has been achieved, while retaining argon as the starting gas. Although there are conditions under which other gases may be useful, it is very desirable to be able to employ argon.

Early Observations on Lamps of Round Cross Section

The unexpected light output characteristics of various sizes of conventional lamps as wattage was varied was the start of the work described in this paper. If light output is plotted as a function of wattage for a half-inch diameter lamp and a one-inch diameter lamp, both 18 inches long, results as shown in Fig. 1 are obtained. At a value of 15 watts on the T8 curve is indicated a point of normal current density (amperes per square inch cross sectional area of the tube) for this lamp. A similar point has been marked on the T4 curve, representing this *same* value of current density. Also indicated are points on both curves showing twice this normal value of current density. The straight line drawn from the origin indicates the locus of a point of constant efficiency; any point below or to the right of this line represents a lower efficiency.

It will be seen that the luminous efficiency of the smaller tube exceeds that of the larger size at values below about twice the usual current density. At the twice-normal point it is about equal to the efficiency of the larger tube at normal loading. Note the higher rate of loss of efficiency of the larger diameter tube (as shown by flattening of the curve) as the current density is doubled. Something about the geometry of the two lamps permits the one of smaller diameter to operate at slightly more than twice the current density of the larger size without suffering the expected drop in luminous efficiency.

Obviously, in order to create a large package of light, it is necessary to do more than make small diameter lamps of improved efficiency. It is necessary to retain the desirable feature of small tubes—that of withstanding a substantial increase in loading at high efficiency — without sacrificing the higher wattage capability of larger tubes. It would appear that the way of accomplishing this is with other than round tubes.

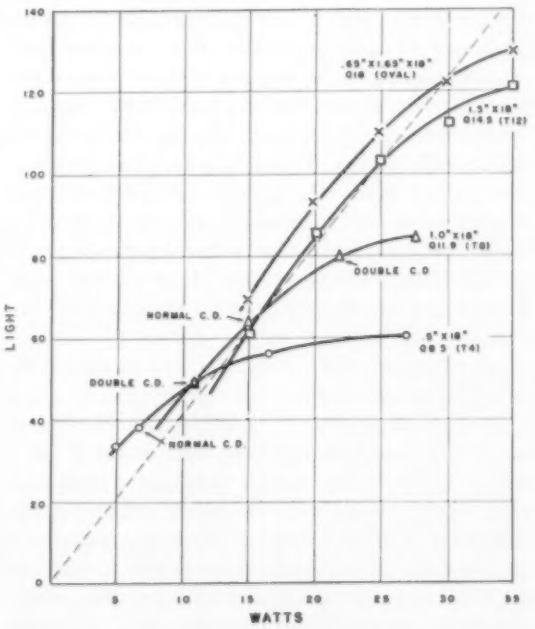


Figure 1. Light output *vs* wattage for experimental lamps of various bulb sizes and cross sectional shapes.

A paper presented at the National Technical Conference of the Illuminating Engineering Society, September 9-13, 1957, Atlanta, Ga. AUTHORS: Large Lamp Department, General Electric Company, Nela Park, Cleveland, Ohio.

Lamp Performance as a Function of Ratio of Circumference to Cross Sectional Area of Bulb

If the effect of diameter is examined more closely, again with the aid of Fig. 1, it will be seen that points can be chosen on the performance curves for 0.5-inch, 1-inch and 1.5-inch diameter lamps, representing the same efficiency. At these equal efficiency points, it is seen that the corresponding values of light (and wattage) are to each other approximately as the square roots of their respective bulb diameters. See Table I.

TABLE I — Watts and Light at Constant Efficiency vs Bulb Diameter.

Diameter, inches	$\sqrt{\text{Diameter}}$	Watts	Relative Light	Relative Light / Watts
0.5	.707	12	51	4.25
1.0	1.0	15	64	4.27
1.5	1.25	21	89	4.24

For reasons which will follow, it is desirable to express this in the following manner:

At constant efficiency, wattage and lumens are proportional to $P^2/A^{0.75}$, where P = periphery and A = cross sectional area of the bulb.

In this form, one can immediately see the effect of the ratio of the periphery to the area of cross section. In low pressure discharges in non-circular cross section envelopes, the shape of the discharge is determined, within certain limits, by the shape of the tube. As long as these limits are not seriously exceeded, the concept of $P^2/A^{0.75}$ can be applied. In Fig. 1, data for a lamp having a flattened cross section are also plotted, along with the round cross section lamps. It will be seen that performance of the oval lamp exceeds that of the round lamps in efficiency at all wattages — i.e., unlike the small diameter lamp, it is able to perfrom as desired at higher wattage levels. This is a basic feature of lamps of suitable non-circular cross section.

The expression $P^2/A^{0.75}$ may very conveniently be used by reducing it to a numerical value and using it as a figure of merit (Q) for loadability of the bulb shape. This figure is shown as the Q value in Fig. 1. Table II shows a comparison of figures of merit for lamps of various sizes and shapes. If such lamps are of equal length, have the same composition and pressure of starting gas, and if the mercury vapor pressures are similar (comparable minimum bulb wall temperatures), then the wattage loadings for equal efficiencies will be approximately in the ratio of the figures of merit.

TABLE II.

Tube Dimensions	Figure of Merit
.5″	8.5
.27″ x .75″	11.8
1.0″	11.9
1.5″	14.5
1″ x 2.3″	18.6
.75″ x 2.5″	28.0

These are empirical facts, however, and do not explain why it is possible to raise wattage of fluorescent lamps and yet maintain high efficiency by using bulbs having certain non-circular cross sections. An anomalous situation exists in that a desirable result is created by moving the walls closer to the center of the discharge, at the same time that the rate of loss of ions and electrons to the tube walls is increased. There must be a compensating decrease in other losses to permit higher efficiency to be obtained at the same wattage or to permit higher loading at comparable efficiencies.

Physical Principles Involved

These mechanisms[1] are as follows. With a bulb having a closer proximity of the walls, ions and electrons are lost at a greater rate to the tube walls. The smaller number of electrons which remain are still the chief carriers for the current that is permitted to flow through the lamp by the ballast. This requires that they drift down the tube faster and this is made possible by the higher voltage gradient that is established. This increased gradient also raises the electron temperature, and as a result, the smaller number of electrons is able to work more efficiently in producing resonance radiation as well as the necessary ions.

If complete control over the electrons were possible, and if a single velocity could be imparted to them for the purpose of producing resonance radiation upon collision with mercury atoms, a velocity equivalent to 50,000 or 60,000°K would be used. No such method of control is known. Electron temperatures have a Maxwellian type of distribution and in ordinary fluorescent lamps this averages 11,000°K. Only a very small fraction of the electrons have velocities suitable for maximum effectiveness in producing 2537 radiation. Thus, any increase in electron temperature increases the number of excited mercury atoms, which emit resonance radiation upon return to the ground level, provided that cumulative ionization or other undesirable mechanisms do not interfere.

Dr. Carl Kenty[2] points out that destruction of excited atoms by dissipative processes is a function of their concentration as well as of the concentra-

tion of electrons which destroy them. It is desirable, therefore, to reduce the concentration of both of these particles. For a given level of 2537 production, the concentration of excited atoms is reduced by minimizing the distance from the point of generation in the arc to the phosphor on the bulb wall. This reduces the opportunity for their re-formation at the expense of 2537 quanta reabsorbed. On the other hand, due to the fact that fewer electrons (working more efficiently at higher electron temperature) are present, the probability of the dissipative excited atom-electron interaction is further reduced. Not only is it desirable to have this smaller electron concentration, but also the higher electron temperature. Loss of electron energy because of elastic collisions with argon atoms increases roughly as the 5/2 power of the electron temperature while probability of excitation of mercury atoms, and therefore production of 2537 radiation, increases even faster — *i.e.*, exponentially. The result is to decrease the relative elastic losses in comparison with the rate at which 2537 energy is delivered at the tube wall. Because elastic collisions represent a major form of energy loss in conventional fluorescent lamps, this relative reduction can play an important part in obtaining high efficiency of suitable non-circular cross section lamps.

All of these desirable effects can be obtained by reducing the distance to the phosphor by use of either small tubes or with suitable non-circular bulb shapes, and the result is an increase in efficiency. If, in the T4 lamp, the population of excited atoms is increased by raising the current density, it is found that it can be about doubled before the dissipative effects limit the efficiency to that of the larger diameter bulb.

We may recapitulate by pointing out that the close proximity of the bulb walls results in the ability either to increase efficiency at normal loadings or to load the lamp more heavily at good efficiency because:

1. Electron temperature is increased, resulting in more effective production of excited mercury atoms.
2. Voltage gradient is raised, making it possible at any given current to put more energy into the arc, per foot of the lamp's length, with the desirable result mentioned in the following item.
3. Relative wattage expended at the electrodes is reduced for any given lamp current or absolute electrode wattage losses are reduced at any given value of lamp wattage because of the resulting lower current.
4. Opportunities for energy-dissipating processes to occur are minimized because of the smaller concentrations of both electrons and excited atoms. Yet the effectiveness of production and delivery of the necessary 2537 radiation at the walls, is enhanced.
5. The ratio of energy lost through elastic collisions, to the energy (as 2537) received at the bulb wall is very appreciably reduced because of the use of fewer electrons at higher electron temperature.

Thus, in a qualitative way, the gas discharge phenomena involved in the non-circular cross section discharge are understood. Dr. Kenty is conducting a rigorous quantitative analysis of some of the processes involved and will undoubtedly publish the results of this study at a later date.

Evolution of Lamp Having Non-Circular Cross Section

The above-mentioned concepts have permitted the making of practical lamps having high efficiency at high wattage loading, but the bulb configuration now in use was not at first obvious.

It is necessary to retain the desirable characteristics brought about by close proximity of surfaces on which to lose ions and electrons, and yet to be able to increase wattage loading to more useful levels. Work was first done toward the use of conventional round bulbs having internal structures in addition to the bulb wall for trapping ions and electrons, thereby creating these desirable conditions. An outside phosphor-coated tube placed within the conventional bulb was an obvious approach. Phosphor-coated perforated discs supported in the path of the arc have also been tried. Although all such attempts were very effective for increasing electron temperature, lamp voltage and internal generation of light, all have suffered the rather serious drawback of being unable to radiate efficiently, from a geometry standpoint, the light that is generated. Their efficiencies were superior to those of round tubes only at quite high loadings. The conclusion was arrived at that to effectively increase efficiency, the phosphor-coated ion and electron trap would have to be the bulb wall itself.

In choosing the shape for a non-circular cross section, it is necessary to start with a minor dimension comparable with the diameter of a small tube and combine it with a major dimension consistent with the ability of the discharge to fill the resulting space. This provides a discharge space much larger than would be present in round tubes having a similar proximity of tube walls.

A flattened, or oval, tube is the simplest to make

and is the most effective shape for providing ion and electron entrapment as well as for permitting escape of the light generated. It has but one drawback. Its strength is too low to withstand safely the force of atmospheric pressure for tubes with a periphery much greater than three inches unless the wall thickness is greater than normally considered practical for quantity lamp production. It is also unduly flexible in one direction, and would bend excessively, especially in long lamps.

Other shapes were investigated, including a "Y" cross section, but the "U" shape satisfies the requirement of rigidity, and greatly increases strength, enabling one to make lamps of any reasonable length, having a periphery of about four inches. For larger sizes, the use of "bridges," *i.e.*, zones of round cross section at suitable intervals along the length of the lamp, is quite effective. Their use, of course, reduces to some degree the potential output of the lamp.

In designing a high wattage lamp having a "U" cross section, the first decision to be made concerns the periphery of the lamp. This should be kept as large as possible, consistent with reasonable handling, for several reasons:

1. Wattage dissipation per unit surface area should be kept as low as possible in the interests of operating temperature and lumen maintenance.
2. Starting voltage must be kept from exceeding the Underwriters' limit of 600 volts. This limit is imposed if the lamps may be used in a building having dwelling occupancy and using bases which are not designed for primary circuit disconnect.
3. It is further desired to keep the ratio of starting to operating voltage as small as possible so that ballast size and losses may be kept to a reasonable figure.

The largest commercially-made fluorescent lamp bulb, the T17 size, was therefore selected. In order to determine the minor dimension, it is necessary to consider the degree to which the arc will spread. If this dimension is too small, the arc may move, or flicker. If the cross section is not symmetrical, it will remain off to one side. Items that have an effect on the arc's ability to spread are the kind and pressure of filling gas, and the pressure of the mercury. Argon at approximately 1.5 mm has been chosen for reasons to be described, and mercury pressure is in the neighborhood of 7 microns. Under these conditions, the discharge will spread to about three times its minor dimension.

This indicates a minor dimension of .75 to .85 inches for a perimeter of 6.66 inches, based on the T17 bulb size. The cross section shown in Fig. 2 is a desirable shape for the grooved portions of a lamp having "bridges." The figure of merit for such a bulb is slightly less than 28 because of the presence of "bridge" zones, compared with 14.5 for a T12 bulb. For lamps of equal length, operated at equal efficiency, the non-circular lamp should therefore operate at lumen and wattage values nearly 28/14.5 times those of the T12 lamp. Fig. 3 shows a reasonable agreement with this calculation in that the non-circular lamp produces nearly twice as much light at 120 watts as does the lamp of round cross section at 60 watts. That is, a high efficiency is maintained. Note that the performance of the non-circular cross section lamp exceeds that of the conventional lamp at all loadings. At any wattage, the extra lumens in a sense might be said to have come from the changed configuration of the glass bulb.

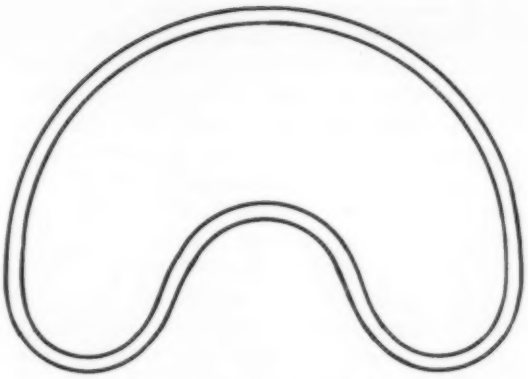


Figure 2. Desirable shape for bulb cross section.

Starting Gas — Its Effect on Discharge Characteristics and Cathode Performance

Another item of design that strongly affects lamp characteristics is composition and pressure of the starting gas. The effects of the various starting gases in lamps of non-circular cross section are very much the same as in round tubes, but at different wattage levels. The very heavy gases, krypton and xenon, show an improvement in efficiency as compared with argon only in large tubes with walls remote from the center of the discharge. Their advantage becomes less as the walls are moved closer to each other. This result may be, in part, due to energy losses incident to excitation and ionization of the starting gas. This is caused by both the higher electron temperature in the non-circular lamp and the low excitation and ionization levels of these gases. To minimize the relative

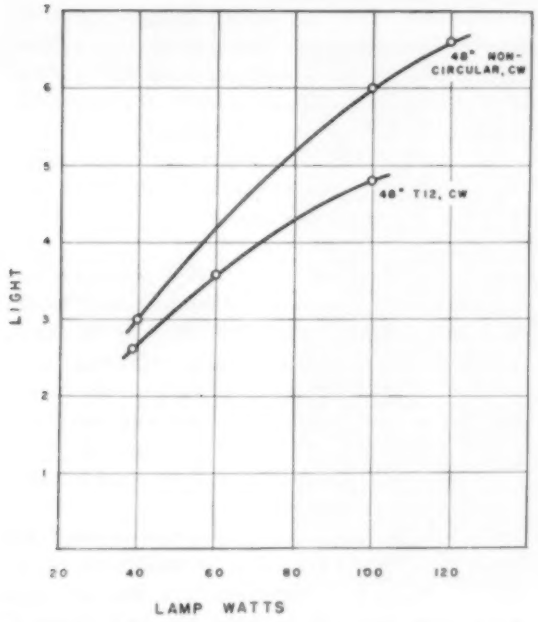


Figure 3. Light output *vs* wattage for 48-inch lamps differing in cross sectional shape.

importance of these conditions, it has been found necessary to reduce the population of the filling gas atoms to a low level by using pressures less than one mm. Under these conditions, the cathode protection usually associated with these gases disappears. No advantage has yet been found for the use of krypton or xenon as the major starting gas in the present form of this non-circular cross section lamp.

The lightest gas with a low Ramsauer cross section is neon. This cross section is in effect the target size to electrons. To offset the greater elastic collision losses of neon, resulting from its lower mass and slightly larger cross section than that of argon, it is necessary to use a low filling pressure (about 1.5 mm). At this pressure, neon offers protection to the cathode (against positive ion bombardment) equivalent to that of argon at approximately 0.75 mm. Experience indicates that this is extremely hard on cathodes unless the structure is larger and is heated by a considerably greater expenditure of wattage than necessary for argon.

Whereas an arc current of 1.5 amperes gives good operation with argon at 25 watts per foot in the present form of non-circular cross section lamp, approximately 3 amperes are required for loadings of 50 watts per foot. Use of neon, however, provides 50 watts per foot at a current of approximately 1.75 amperes. At this lower current, electrode losses are reduced and this saving counterbalances the poorer positive column efficiency of neon so that total lamp efficiency remains essentially unchanged. At still higher wattages, the use of neon may be desirable, but serious problems remain to be solved, some of which are described below.

Unfortunately, in all fluorescent lamps, the starting gas pressure necessary to provide ideal protection for the cathodes in the sizes used is higher than the pressure which yields best efficiency. With argon the difference between these two requirements is much less. For this reason, and because of its satisfactory starting characteristics, argon has been chosen.

Lamp Efficiency as a Function of Cathode Heating Power Necessary for Adequate Life

Many years ago, Dr. A. W. Hull[3,4] learned how to make cathodes having very long life in gases at very low pressures. In brief, to apply his principles, it is necessary but to make the emitting surface large enough and to operate it at a suitable temperature to supply thermionically all the electrons needed. To accomplish this in fluorescent lamps demands more cathode heating wattage than presently used.

One of the important features of the "Rapid Start"[5] principle, which is utilized in this non-circular cross section lamp, is that the wattage consumed in heating the cathode is very nearly the same as the reduction in arc wattage, due to reduction of cathode fall, when the cathodes are heated. To exceed this wattage level, as is at present required if neon at a pressure of 1.5 mm were to be used, would place an additional wattage on the lamp.

It is considered good practice to include all cathode heating wattage as part of the rated lamp wattage even though it may be difficult to measure accurately. By taking advantage of the cathode heating watts supplied, but by excluding them in the rating of the 96-inch non-circular cross section lamp, apparent efficiency would increase nearly 4 per cent. Twice this apparent increase would be realized in the 48-inch lamp.

Mercury Vapor Pressure Control

Still another item of importance is the mercury vapor pressure. A pressure range of 5-7.5 microns, equivalent to a condensed mercury temperature of 38-43° C produces maximum efficiency because this concentration of mercury atoms results in the opti-

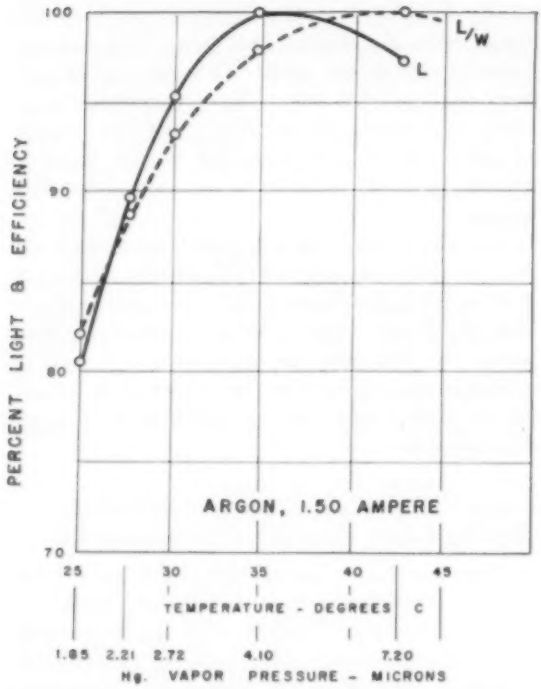


Figure 4. Relative light output and efficiency *vs* mercury vapor pressure for non-circular cross section lamps at constant current.

mum balance between excessive trapping of resonance radiation on the one hand and a reduced probability of excitation due to a scarcity of mercury atoms on the other hand. This is plotted in Fig. 4. Slightly below this vapor pressure region (4.5 microns, 36° C) is to be found the maximum of light output at constant current because of the combination effect of slightly reduced efficiency with wattage increase. The regions of minimum temperature are to be found all along the length of the non-circular cross section bulb. It is especially important for cool areas to be present near the center of the lamp, where mercury prefers to collect for reasons other than temperature difference, as a result of electrophoresis effects.

* * * * *

The integration of these many principles has resulted in the line of lamps commercially known as "power groove." These are very useful lamps for many lighting applications requiring large amounts of light per lamp. As has been the experience with other fluorescent lamps, new techniques of lamp-making and a greater acceptance of the lamp will result in increased light output and a reduction in lighting costs.

We wish to thank the many people in our Glass Department for their major contributions in the field of design and manufacture of this new bulb shape. We also wish to thank Dr. Carl Kenty of the Lamp Development Department for his many suggestions and for his help in understanding the mechanisms involved in the operation of the discharge.

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2. Kenty, C.: "Production of 2537 Radiation and the Role of Metastable Atoms in an Argon-Mercury Discharge," *Journal of Applied Physics*, Vol. 21, 1950, p. 1309.

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Index to 1957—

Officer-Committee Directory

The annual Index to 1957, which will be published as Part II of the January 1958 issue, will give the business addresses, when available, of I.E.S. Officers and committee personnel for 1956-1957 and 1957-1958, and so can be used as a Directory for these active I.E.S. members.

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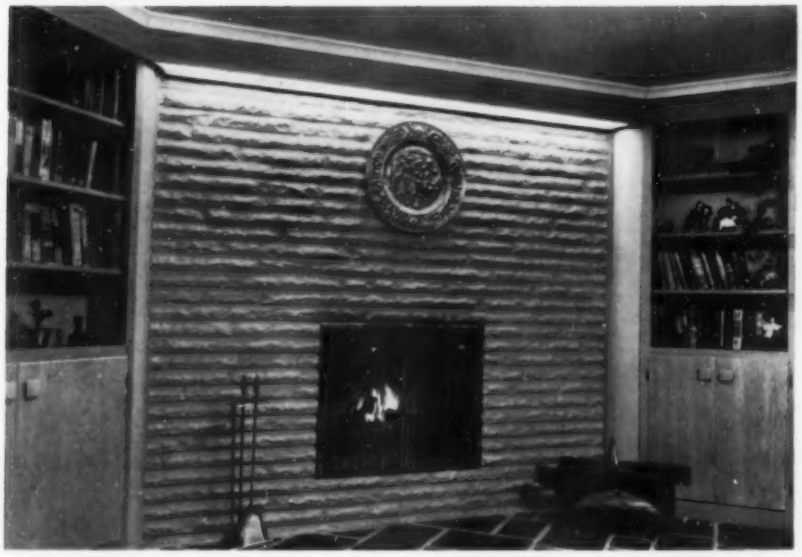


INSTALLATION A: in home of Mr. and Mrs. F. G. Thomas, Columbus, Ohio.

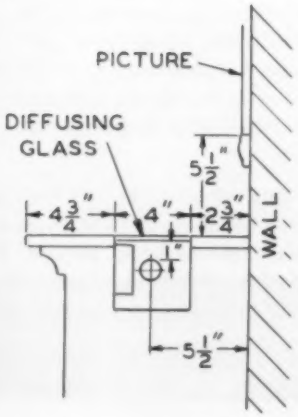
Techniques for Lighting Fireplace Walls

LIGHTING OBJECTIVE: To provide decorative lighting on the fireplace wall and some general illumination in the adjacent area.

GENERAL INFORMATION: In Installation A the stone fireplace wall is 8 feet 2 inches wide. The room ceiling height is 8 feet. The stone is very light gray (50% RF), the wood trim around the fireplace and in the bookshelves is natural birch (60% RF), the ceiling is white (80% RF) and the floor is slate (approximately 20% RF).

In Installation B the fireplace mantel is 52 inches high, 81 inches wide and extends 11½ inches into the room.

INSTALLATION B: in home of Mr. and Mrs. Donald Cotton, West Caldwell, N. J.



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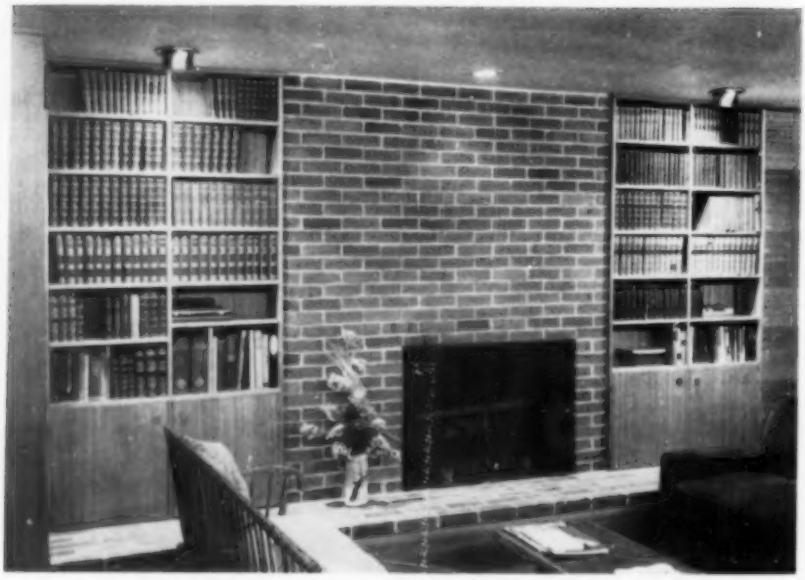

INSTALLATION C:
in home of Mr. and Mrs. John O. Stoddard, Barren Hill, Pa.

In Installation C the fireplace wall is 13 feet 6 inches long of which 6 feet 3 inches is natural color redbrick (25% RF). It is 6 feet 11 inches high from the raised brick hearth. The wood trim of the bookcases and cabinets is bleached mahogany (40% RF), the ceiling is white (80% RF).

INSTALLATION: The lighted soffit of installation A measures 8 inches down from the ceiling, extends the full width of the stone wall and is 8½ inches deep. A 6-inch wide panel of frosted glass, in two sections, is used as a diffuser 3 inches below two 40-watt T-12 de luxe warm white fluorescent lamps placed end to end. The soffit cavity is painted white for good reflectance. Illumination readings on the wall are: 45 footcandles, 18 inches down from the soffit; and 15 footcandles, 36 inches down from the soffit.

Lighting of the fireplace wall of installation B is provided by one 40-watt T-12 de luxe warm white fluorescent lamp recessed in the mantel as shown in the drawing. Illumination readings on the painting are: 34 to 48 footcandles at the bottom (5½ inches above the mantel) and 8 footcandles at the top (33½ inches above the mantel).

One Litecraft catalog No. F344 louvered recessed unit equipped with one 75-watt R-30 flood lamp and two Litecraft catalog No. 6508 adjustable recessed units each equipped with one 150-watt R-40 flood lamp are installed 9½ inches and 7 inches respectively from the wall in installation C. The adjustable units are aimed to highlight the book shelves. Illumination readings on the bookcase and fireplace wall are: 142 footcandles 18 inches down from the ceiling and 48 footcandles 36 inches down, on the center of the book shelves; 35 footcandles 18 inches down from the ceiling and 13 footcandles 36 inches down, on the center of the brick wall.

Lighting data submitted by (A) Miss Blanche Waggener of Columbus and Southern Ohio Edison Co., 215 N. Front St., Columbus 15, Ohio. (B) Miss Eve Freyer, Westinghouse Lamp Division, Bloomfield, New Jersey. (C) Miss Elizabeth Meehan, Philadelphia Electric Co., Philadelphia 5, Pa., as illustrations of good lighting practice and to aid in the design of similar installations.

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11-57

Application of Non-Circular Cross-Section Fluorescent Lamps

By G. R. BAUMGARTNER
R. T. DORSEY
E. A. LINSDAY

INCREASED light output per foot of fluorescent lamps, at efficiencies comparable to previous sources has always been important for improving lighting. The introduction was made over a year ago of a non-circular cross-section design having these characteristics, together with acceptable life and lumen maintenance.[1] Since then, it has been applied in most major lighting fields. Moreover, still higher output per foot is inherent in this design, and improvements in efficiency, life, and maintenance are expected.

The purpose of this paper is to describe the lamp and its characteristics, discuss its photometry, cover broad design considerations, and to describe how it can and is being used to advantage.

In the early days of the fluorescent lamp, considerable work was done and methods evolved to arrive at a rapid and reliable testing procedure for fluorescent lamps, both bare and in lighting equipment. These results were reported in 1941 at a National Technical Conference of the Illuminating Engineering Society in Atlanta, Ga.[2] At that time, fluorescent lamp bulbs were generally circular in cross section. (There were a few of oval cross section, but they were limited to low wattage and short lengths for specialized applications.) Factors were established which correlated lumen output and candlepower, considerably simplifying photometry.

Bulb Construction

The radically new fluorescent lamp design is illustrated in Fig. 1; a T17 ($2\frac{1}{8}$ inches) cylindrical glass tube with concave grooved sections pressed into the cylinder. For purposes of later discussion of lamp construction and brightness, the various areas are identified in Fig. 2. The cross-section of the bulb is circular between grooves and is referred to as a bridge. The bridges serve to increase bulb strength. The arc stream is concentrated in the area between the T (tubular contour) and G (groove). The maximum bulb wall brightness occurs in the center of the groove. The rails are lowest in brightness. The variation in brightness results in unequal candlepower distribution, Fig. 4.

Lamp Brightness

Brightness measurements at a number of points along the bulb are shown in Table I. Values are for the 96-inch lamp operating at 13,000 lumens with grooves down.

Candlepower Distribution

Straight tubular lamps have required, in general, only one candlepower measurement perpendicular to the lamp, prior to testing in equipment, because of the uniform brightness and light distribution around it. Ratio factors (lumens to candlepower perpendicular to lamp) have long been established.

With non-circular cross-section lamps, the candlepower distribution perpendicular to the lamp varies, and checks at G-A-A′ and T (Fig. 3) are required.

Because of this variation, lumens in each of the 90-degree sections (Fig. 3a) must be determined in order to obtain total lumen output.

The candlepower distributions shown in Figs. 4a and 4b were measured in the respective planes illustrated in Fig. 3b. In Fig. 4c, however, it can be seen that the candlepower curves in Figs. 4a

A paper presented at the National Technical Conference of the Illuminating Engineering Society, September 9-13, 1957, Atlanta, Ga. AUTHORS: Large Lamp Department, General Electric Company, Nela Park, Cleveland, Ohio.

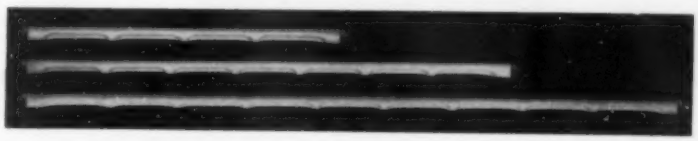


Figure 1. 48-, 72- and 96-inch T17 lamps with grooves.

TABLE I — Brightness — Footlamberts.
(See Fig. 2.)

Sections	1	2	3	4	5	6	7	8	9	Lamp Area Integrated
T	——	5900	6150	——	——	6500	6800	——	——	1″ Sq.
A & A′	——	4050	4200	——	——	5050	5050	——	——	1″ Sq.
G	8450	8650	8850	9250	9200	9250	9200	9400	8250	½″ x 2″
GRA & GRA′	3700	3500	3950	3800	3720	3650	3750	4150	3650	½″ x 2″
BT		4150				4600				1″ Sq.
BA & BA′		4250				4350				1″ Sq.
B		4300				4400				1″ Sq.

Measurements Based on 13,000-Lumen 96-Inch Lamp

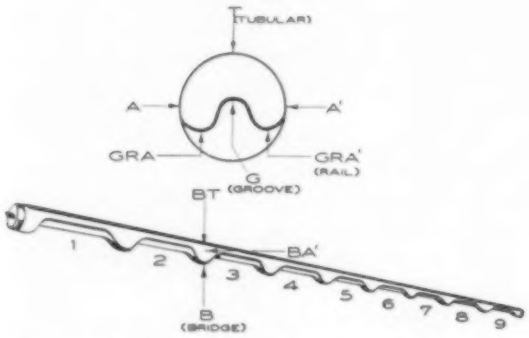


Figure 2. Bulb identification, showing regions and stations for brightness data.

and 4b do not represent the averages in their 90-degree section. These average candlepowers are obtained from readings at 10-degree intervals in the curve of Fig. 4c. Considering the T curve (Fig. 4a) as an example, each of its candlepower values is to be lowered by the ratio of the average candlepower in the T-section Fig. 4c to the 90-degree value at T.

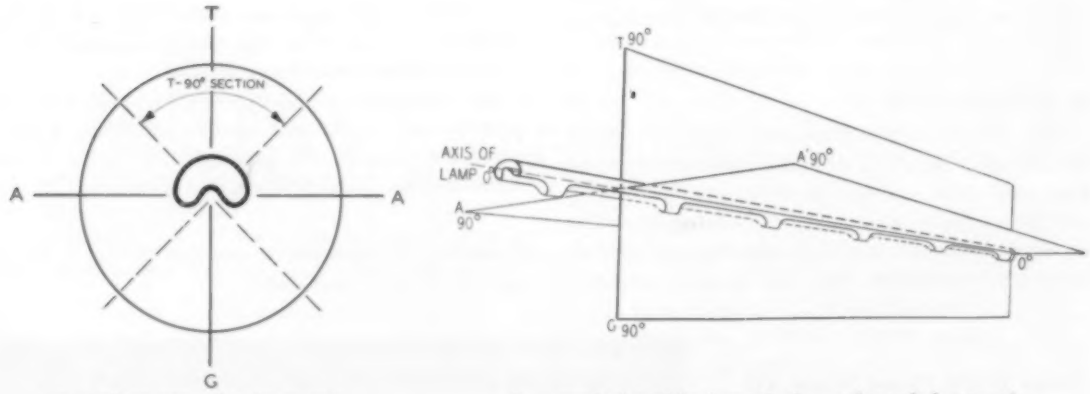
Each of the T-plane candlepowers (Fig. 4a) thus corrected may now be multiplied by one-fourth of the conventional 10-degree zonal lumen constant. The sum of these eighteen products yields the total lumens in this 90-degree section.

This procedure is repeated for the G, A, and A′ 90-degree sections. Note that the G curve like T is reduced and that A and A′ are increased.

Now, if the light output of each section is divided by its 90-degree candlepower (G-A-A′ and T), there will result four section ratios for the respective 90-degree sections, Table II.

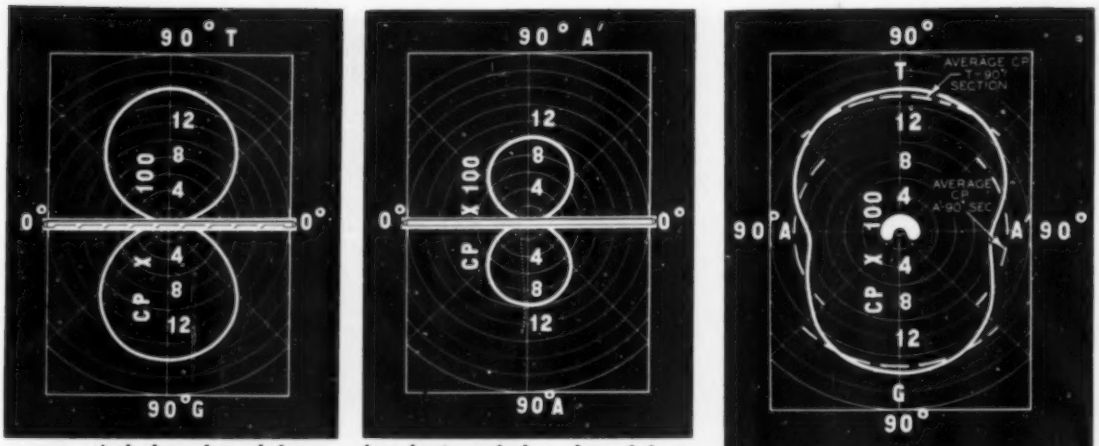
TABLE II — Lumen-to-Candlepower Ratios for 90-Degree Sections.

	Test F	Test G	Average
Lumens in Section T	3628	3677	
———	——— = 2.30	——— = 2.37	2.34
Measured 90° cp — Plane T	1576	1551	
Lumens in Section A	3054	2610	
———	——— = 2.80	——— = 2.83	2.82
Measured 90° cp — Plane A	1092	923	
Lumens in Section A′	2535	3077	
———	——— = 2.81	——— = 2.83	2.82
Measured 90° cp — Plane A′	902	1088	
Lumens in Section G	3784	3636	
———	——— = 2.31	——— = 2.26	2.28
Measured 90° cp — Plane G	1635	1608	
Sum of Lumens	13,000	13,000	
Sphere Reading	12,838	13,142	
Difference	1.2%	1%	



a — plane normal to lamp axis. **b — vertical and horizontal planes through lamp axis.**

Figure 3. Planes in which light distributions were measured (see Fig. 4).



a — vertical plane through lamp axis.

b — horizontal plane through lamp axis.

c — plane normal to lamp axis.

Figure 4. Candlepower distribution for 96-inch lamp 13,000 lumens.

These four section ratios for G-A-A′ and T provide a means for determining the lumen output of this lamp type assuming similar distribution characteristics to those which were measured. Where data are to be reported in terms of published lamp output, brightness, candlepower, and section lumens should be adjusted in the ratio of total measured to published values. These specific ratio values may be modified if candlepower distribution (Fig. 4) changes.

The fundamental photometric principles involved in this method are applicable to the measurement of total light output where spherical photometry is not available. Comparative measurements in a spherical photometer and by this procedure show an agreement within two per cent. The method described is equally applicable to the determination of total output of extended sources such as reflector fluorescent and of other non-symmetrical distributions. It also offers a simple means for analyzing relative light output distribution by sections which a single lumen integration does not provide.

Experience indicates that the selection of non-circular cross-section test lamps, their seasoning, alignment, and photometric characteristics must be more closely evaluated than with circular cross-section lamps. Also, lamps should be operated in the in-service position during seasoning, bare lamp rating and photometric testing in fixtures.

Lamp Depreciation

The lumen maintenance curve is shown in Fig. 5. At present these values are lower than for other fluorescent lamps because of the higher loading. Cost of light calculations for this lamp indicate an economic life of about 5000 hours, and the published life is currently based upon this value. The 100-hour rating is, of course, used as 100 per cent light output.

Lamp Performance Under Varying Conditions

Because this lamp is substantially higher in watts per foot than previous designs, the subject of lamp temperature in relation to various environments was investigated in some detail.

Effect of Air Velocity

Fig. 6 shows the marked effect of low velocity air movement and the relative unimportance of higher velocities (above 3 mph). Most testing was there-

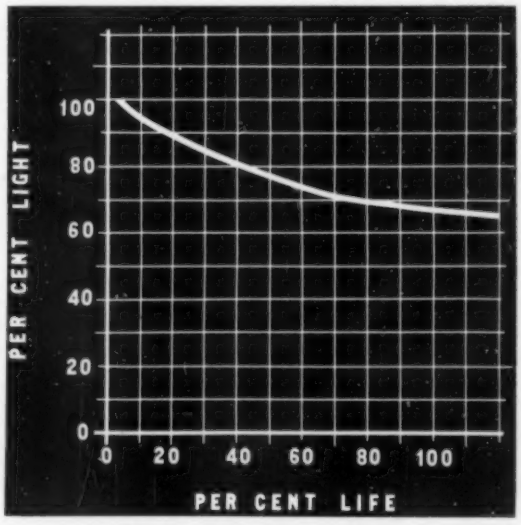


Figure 5. Lumen maintenance.

fore done in the range of indoor rates of air movement (1-3 mph).

Minimum perceptible draft is approximately 1 mph.

Effect of Ambient Temperature

Fig. 7a shows the effect on light output and watts for a bare lamp in open air over a wide range of ambient temperatures. Fig. 7b shows the marked effect on these variables with an air movement of three miles per hour.

Fixture Design

This high light output per foot lamp is particularly advantageous in many lighting fields. With lower first costs for the lighting system as compared to other fluorescent installations and with the same or lower operating costs, it is becoming accepted as a preferred system for general lighting. With two-lamp fixture outputs over 20,000 lumens, it widely expands the potential market for fluorescent.

Although it is markedly lower in brightness than filament and mercury lamps, it is higher in brightness than other fluorescent types. Brightness control in fixture design is therefore of almost paramount importance. This consideration as well as environmental treatment of room surfaces; *i.e.*, light reflectances on wall, ceiling, floor and machinery, to produce satisfactory lighting systems at any mounting height is the principal concern of this discussion.

Simply substituting this lamp in existing fixture designs intended for slimline or high-output lamps may result in poor photometric and temperature performance.

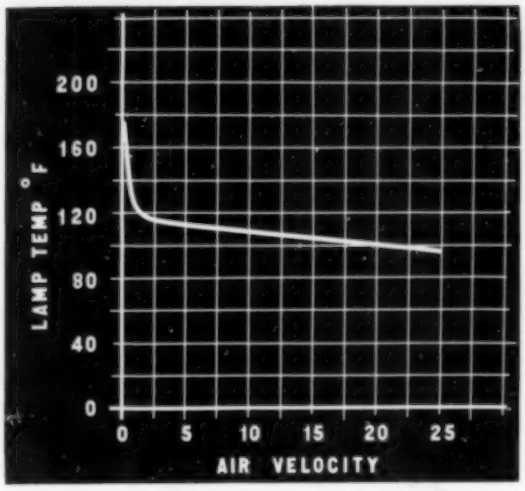


Figure 6. Lamp temperature vs air velocity.

Using diffusing media (luminous ceiling, for example), for the same number of lamps and the same area of material, these lamps will produce 2.5 times the brightness as with slimline lamps. Thus, with diffusing materials only one of the advantages is utilized — that of more light from the same number of lamps. As an example, at 100 footcandles, in order to achieve acceptable uniformity of the diffusing surface, the rows would have to be about four feet above the diffuser. Since the proportion of installations in which this space is available is limited, it would appear that these lamps would be used primarily for illumination levels of 200 footcandles and above.

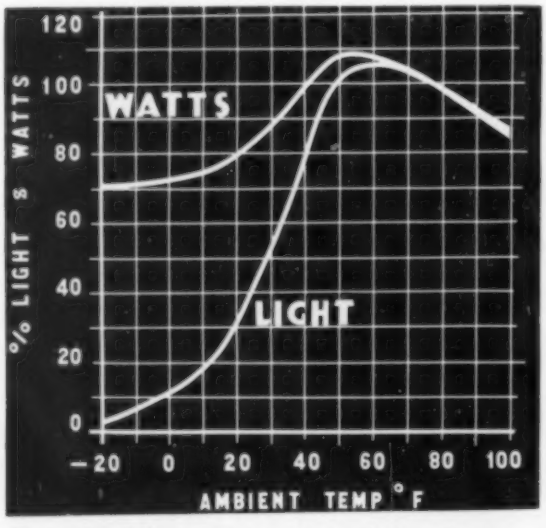


Figure 7a. Effect of temperature on light and watts — bare lamp, still air.

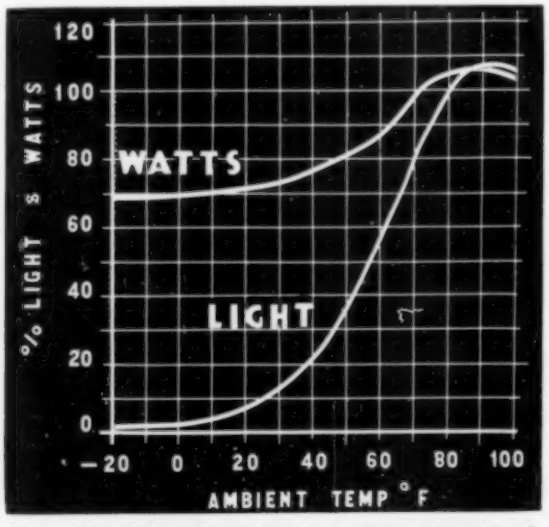


Figure 7b. Effect of ambient temperature on watts and light output of bare lamp with 3 mph draft.

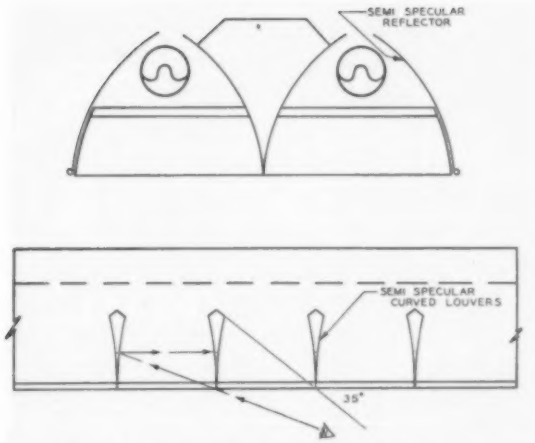


Figure 8. Reflector and louver contour for good control of light and brightness.

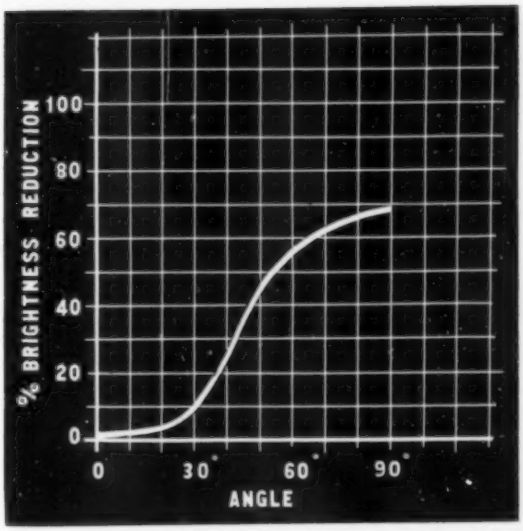


Figure 9. Brightness control of wedge louver over high-reflectance white louvers.

The most promising direction of new developments is the control of light and brightness from the lamps and fixture through the use of specular or semi-specular metal.

At lower mountings and higher illumination levels, adequate shielding and brightness control both perpendicular and parallel to the lamp are important. Brightness control perpendicular to the lamp is relatively simple following traditional concepts utilizing contour and surface finish. Brightness control for lengthwise viewing is not as easily accomplished. A unique solution is shown in Fig. 8.

It will be noted that each louver reflects the adjacent one, thereby minimizing louver brightness. Fig. 9 shows this brightness reduction. An installation of commercially available equipment utilizing this principle is shown in Fig. 10.

Some of the unique features of this system are:

1. 1000 footcandles.
2. comfort comparable to many good systems of less than 100 footcandles.
3. adequate energy dissipation with properly ventilated fixtures at over 30 watts per square foot.
4. minimum fixture weight by use of 400-cycle operation.

There are other situations in which maximum control of light into a narrow wedge-shaped beam is desirable. Using a parabolic contour, it has been found that if the reflector width is about four times

Figure 10. This demonstration workshop is lighted to 1000 footcandles using the new lamp in the fixture shown in Fig. 8. A high degree of visual comfort is obtained by fixture design and control of environment. Air flows through the fixtures, carrying part of the heat away in the upper ceiling space.

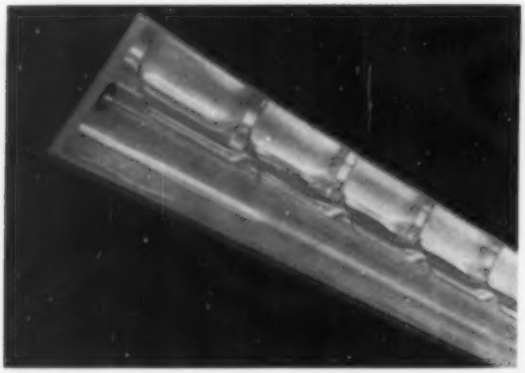


Figure 11. A simple parabolic trough reflector of polished metal, 8 to 9 inches wide, can provide effective control of light in a plane perpendicular to the lamp axis. With the lamp mounted with the groove "sideways," one side of the reflector is filled with the image of the groove and the other with the image of the tubular section

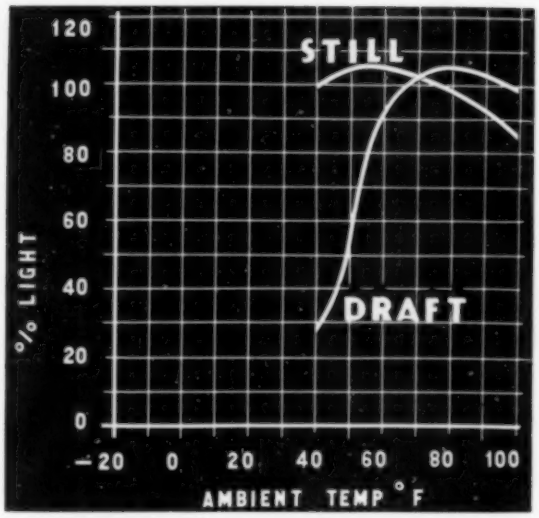


Figure 12. Effect of temperature on fixture of Fig. 8 under still air and draft conditions.

the lamp diameter, a satisfactory compromise between control of light and space requirements is achieved. Thus, with the T-6 lamps a three-inch reflector is used, with T-12 lamps a six-inch reflector, and with the T-17 lamp, an 8½-inch wide reflector gives equivalent results. (Fig. 11.)

Temperature Considerations

More heat is generated by these lamps and ballasts. This means that provisions must be made for adequate dissipation of this heat to keep within satisfactory operating temperatures.

The ballast should be mounted so that there is metal-to-metal contact between it and the metal of the fixture to provide for good conduction. They should also be positioned to minimize heating by the lamps.

With suspended fixtures of suitable design, the natural air currents around the fixture can provide efficient heat dissipation. This is shown by comparing Fig. 7a for the bare lamp in still air and Fig. 12 for the suspended fixture in still air. Both show output of 100 per cent at 77 degrees ambient.

Fig. 13 shows a four-foot square fixture for attached mounting. It will be noted that the ballasts are mounted outside the fixture and that the ballast housing is separated from the fixture body to minimize heating from the lamps and to allow free circulation of air.

Another fixture design consideration is the control of the temperature of the coolest point on the bulb to maintain optimum mercury vapor pressure (and corresponding higher light output). A simple method of accomplishing this is a metal strip approximately one-half inch wide and four or five inches long in spring contact underneath the center of the bulb. This can result in about 6 per cent increase in light output under normal conditions.

Store Lighting Applications

A principal advantage of the new lamp, in addition to reduced cost of light, is the fact that ceiling patterns can be simplified. This, coupled with the brightness control of reflector and louver designs

Figure 13. At the left, a four-foot square fixture incorporating four of the new lamps is compared with a conventional eight 40-watt rapid-start square at right. Note in the fixture on the left that the ballasts are outside the main body to allow for free circulation of air. Louvers are painted gray for reduced brightness. Spacing of lamps in combination with reflector above creates interesting texture.

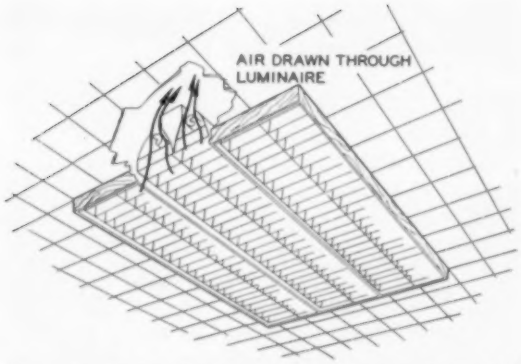


Figure 14. A decorative wood frame surrounds standard fixtures (Fig. 8) designed for the new lamp. For recessed mounting, forced ventilation is needed to keep ballasts and lamps at satisfactory operating temperatures.

previously discussed, can make lighting less distracting and more suitable to architectural designs.

In the supermarket field, an installation is being planned for 200 footcandles using fixtures of the type shown in Fig. 8, but mounted in a somewhat unusual manner. Eight by six-foot openings will be framed in the ceiling and the fixtures suspended slightly above this opening. Air will be pulled through them and exhausted through the space between the furred ceiling and the roof construction. The frame and dividers between the units will be natural wood, as shown in Fig. 14, to help off-set the "mechanical" appearance of the fixtures themselves.

Because of its high output for the space required,

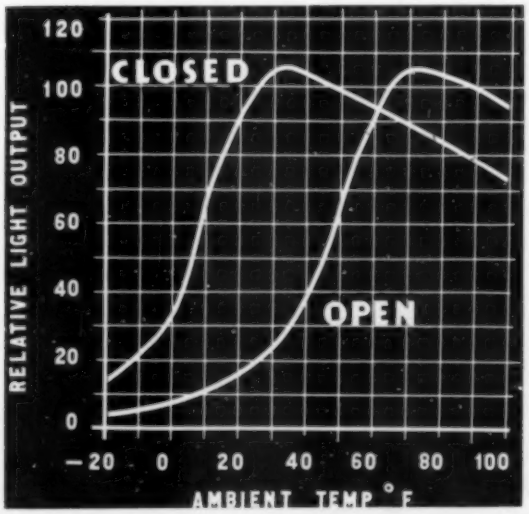


Figure 16. Light output — temperature characteristics of new lamp in small reflector with draft.

Figure 15. The high light output per foot of the new lamp will be useful in show windows to provide part of the over-all illumination with relatively little heating effect. As indicated, incandescent is required for emphasis and highlights.

the new lamp is expected to be particularly useful for display lighting in stores and for supplementary wall lighting, etc., in other areas. Fig. 11 shows one design of specular parabolic reflector.

The new lamp will be used in show windows, too. Fig. 15 shows the new lamps in nine-inch wide specular reflectors installed in a demonstration show window. The lamp is oriented with the groove downward, and the reflector is filled largely with the image of the sides of the lamp.

Brighter reflections in merchandise created by this higher brightness fluorescent lamp may be desirable. On the other hand, reflections in glass-topped showcases would be worse, but with the proper lighting design, the reflections can be avoided for most viewing angles.

Exterior Lighting Applications

Today several large firms are utilizing the new lamp for lighting poster panels. Higher output is needed in this field to compete with higher brightness signs, such as those using enamelled sign lamps brightly lighted store fronts with reflectorized lamps, and enclosed plastic signs.

Field experience and laboratory tests both demonstrate the necessity of using a cover at temperatures below 60 degrees F. Above this temperature

Figure 17. Uniform panel brightness is obtained in this shopping center pylon, using conventional spacing of the new lamps. With fewer lamps to replace than would have been needed using previously available fluorescent types, maintenance is simplified.

there is a thermal advantage in leaving the cover off. These effects are shown in Fig. 16. One excellent plan is being set up by an outdoor advertising firm, in which the reflector will be cleaned twice a year, with the covers to be installed in the fall and removed in the spring. Another advantage of removing the covers is the prevention of overheating lamp bases and lampholders.

Units such as those now being used for poster panels are already finding their way into a variety of other outdoor applications.

In the sign field, Fig. 17 shows a shopping center pylon using the new lamps. Since this sign is in a medium brightness district, lamps were spaced on 16-inch centers and produce 300-footlambert brightness of the faces. Fewer lamps must be maintained than if lower output lamps had been used. For more competitive districts, the required higher brightnesses are easier to obtain.

In the service station field, three new types of units are on the market. One is for lighting the building and is designed to be attached directly to the parapet. It would also serve for lighting posters and fences adjoining the building. The second is for pump islands, and will provide added emphasis at this all-important point of sale. The third is for general illumination of the yard area from pole-mounted positions. The unit in Fig. 18 is an example. Here the higher output is obtained without increasing the sail area of the unit. Moreover, the minimum size of the unit is desirable from the appearance standpoint. This same type of unit will have wide use in other fields, such as floodlighting of playgrounds, outdoor work areas, tees and greens of golf courses, and perhaps protective lighting.

In the sports lighting field, a tennis club is planning to light three indoor courts to 100 footcandles using fixtures mounted in continuous rows along the sidelines of each court. Eight rows of lamps per court will be installed. This location will keep

Figure 18. Floodlighting of areas surrounding beautiful new Albuquerque Civic Auditorium is accomplished by fixtures especially designed for the new lamp. Underneath unit, 15 fc are provided, with an average of 5 fc.

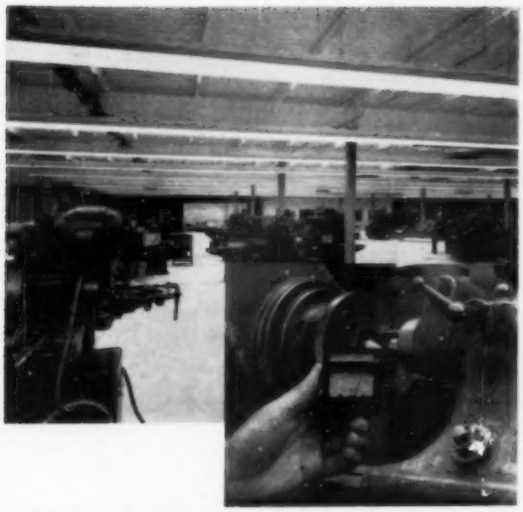


Figure 19. Lighting installation in machine tool manufacturing plant. 150 footcandles maintained with continuous rows of two-lamp fixtures on 10-foot centers.

Figure 20. Various areas in automotive plant are lighted to 60-70 footcandles. Aluminum reflectors give high visual comfort for crosswise viewing.

the units out of direct line of sight for most viewing angles. The same general approach can be used for other sports, such as volleyball, croquet, paddle tennis, table tennis, etc., either indoors or outdoors.

In street lighting, the economic advantages of the new lamp and the increased illumination levels it will make practical are important considerations. Luminaires are now on the market offering 65 per cent more illumination than from the same number of high-output lamps.

Industrial Applications

In industrial lighting, the lower brightness of the new lamp as compared to incandescent or mercury contributes to improved visual comfort. Moreover, since it is a linear source, improved seeing will usually result as compared to using a point source. In most of the areas where fluorescent is not being used, the increased brightness of this lamp is not likely to create any additional problems.

Fig. 19 shows an installation of these lamps in two-lamp modern industrial lighting equipment. These luminaires have good cross shielding, upward light and are finished inside and out with white enamel. The continuous rows are installed on ten-foot centers, which produces a lighting level of 150 footcandles maintained.

Another interesting installation is a substantially larger one in an automotive plant. Several thousand lamps are utilized at different mounting heights in the various manufacturing areas, all of which are lighted with two-lamp fixtures. These are individually spaced to provide a lighting level of 60 to 70 footcandles. The units are of the modern industrial type with 35-degree cross shielding and 25 per cent upward light. In this case, however, they are constructed of semi-specular aluminum which markedly improves the brightness control and the visual comfort from the crosswise viewing direction. Fig. 20 illustrates one area of this plant. It will be noticed in all cases that brightness balance is well

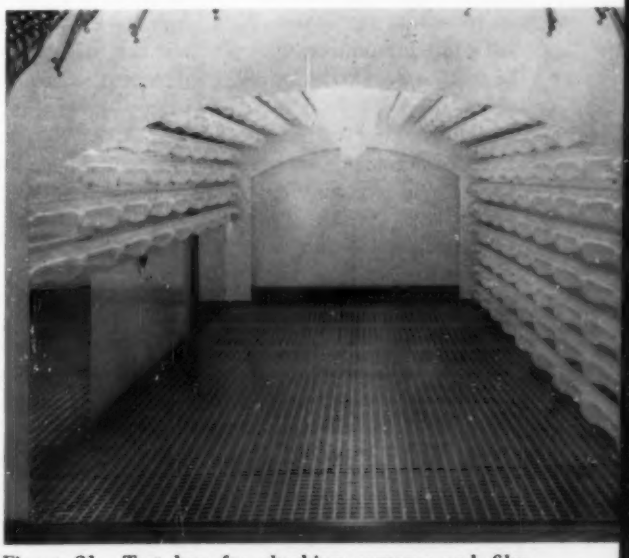


Figure 21. Test box for checking cameras and film packages against light leakage. Several thousand footcandles.

controlled by means of light finishes on room surfaces and substantial upward component of light from the luminaires.

The relatively high brightness and high output per unit area of this lamp has unique advantages for certain types of specialized lighting applications. Where higher levels are required than are easily obtained by conventional sources, this lamp has intrinsic advantages. Fig. 21 illustrates a typical application of this kind. This installation is a test box 5 ft by 8 ft in which cameras and film packages are checked by one of the leading manufacturers for any possible light leakage.

Office and School Applications

As mentioned elsewhere in the paper, luminaires can be designed to give excellent brightness control and corresponding high levels of comfort for application in any environment. Continuous rows of two-lamp equipment on 10-foot centers will produce approximately 150 footcandles. This level is commensurate with good present day practice for offices and some drafting areas. It is easy to obtain levels in the 200- to 500-footcandle range with closer spacing of luminaires, and there is strong indication that applications in the office and drafting field will be moving in this direction, particularly in those areas having difficult visual tasks. One possible difficulty which needs further study and evaluation is the question of reflected glare from these brighter fluorescent lamps. The present ASA standard of school lighting recommends a maximum source brightness of 2000 ft-L where carefully selected reflectances and finishes are used on room and furniture. With luminous ceilings or diffusing luminaires, this problem can, of course, be minimized. With louvered equipment, considerable attention should be given to the possible elimination of shiny surfaces.

There are many areas in and around the school plant in which this lamp is particularly suitable. In the lighting of gymnasiums, swimming pools, and other interior areas with relatively high ceilings, the smaller number of luminaires needed to provide adequate illumination is a distinct advantage from the standpoint of reduced maintenance. The lower cost of installation and operation are further advantages. The lower brightness of the fluorescent lamp as compared to filament and mercury sources makes it particularly desirable in lighting of gymnasiums because of the marked reduction in direct glare for the players and spectators. Also, compared to mercury, color is considerably better. Another area of interest in the school field is the floodlighting of outdoor sports areas, parking lots and traffic areas.

Summary

The radically new non-circular cross-section fluorescent lamp design multiplies lumen output from fluorescent lamps. This new design establishes a plateau on which further developments in lamp performance can be applied. Its higher output and lower cost of light offer opportunities for simpler installation, greater flexibility as to patterns of lighting equipment, and markedly higher lighting levels. Lighting in the past has generally been used to dispel darkness as compared to the ultimate objective of equaling or improving daylighting conditions of the 500- to 10,000-footcandle level. This new development is a major step forward toward obtaining adequate seeing in all fields.

The authors gratefully acknowledge the assistance of their Application Engineering associates for laboratory and consultation.

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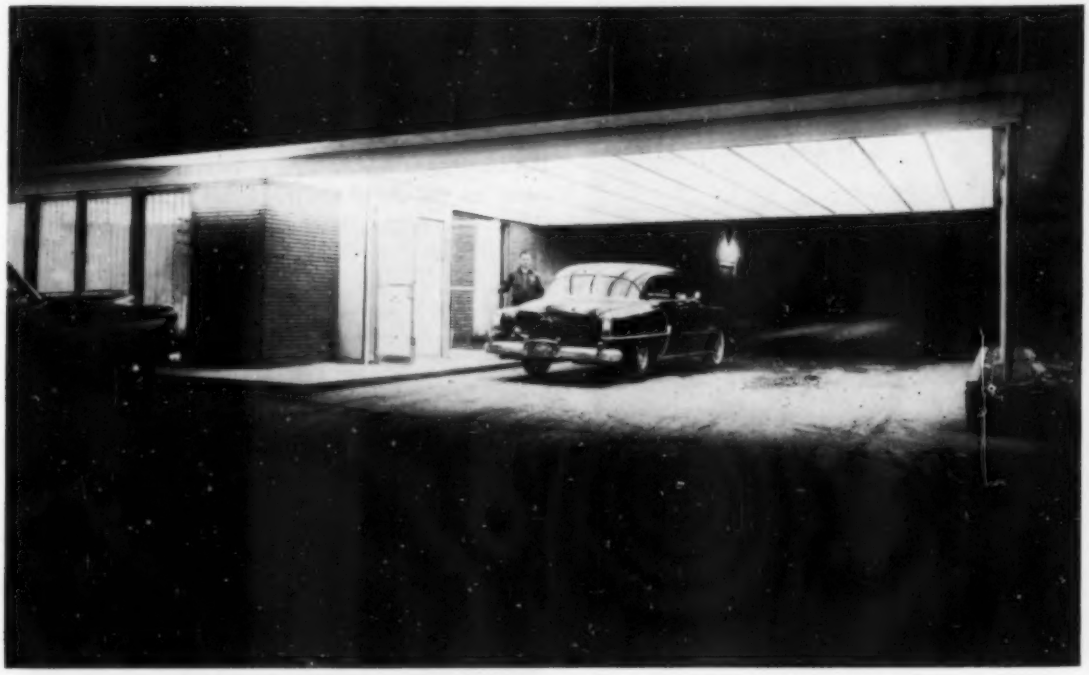
Report on the 1957 National Technical Conference

A complete report on the 1957 Conference in Atlanta, Georgia, with photographs of the major events appears in the Lighting News Section of this issue of I.E.



INSTALLATION AT THE HOLIDAY HOUSE, ROUTE 22, MONROEVILLE, PA.

Lighting a Night Club Entrance

LIGHTING OBJECTIVE: To provide general illumination at an attractive and unusual carport entrance to a night club.

GENERAL INFORMATION: The carport (cedar — 15% RF) is 25 feet long and extends out 29 feet from the night club proper (buff brick — 30% RF). The plastic luminous portion is 8 feet above road and sidewalk (gray — 30% RF). The plenum above the plastic is painted white (80% RF).

INSTALLATION: Seven 22-foot long fluorescent strip units, each equipped with two 96-inch T-8 and one 72-inch T-8 slimline lamps operated at 120 ma, are mounted on 4-foot centers 8 inches above the 23-foot by 28-foot corrugated vinyl plastic luminous ceiling. All equipment except lamps was furnished by Luminous Ceilings, Inc., Chicago, Ill.

The average maintained illumination level under the carport is 20 footcandles.

Lighting designed by A. Zitelli, Duquesne Light Co., Pittsburgh, Pa.; Architect: George Hura, Pittsburgh, Pa.; Electrical Contractor: T. P. Hanlon, Pittsburgh, Pa.

Lighting data submitted by G. H. Maize, Duquesne Light Co., Pittsburgh, Pa., as an illustration of good lighting practice and to aid in the design of similar installations.

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A.I.A. File No. 31

A Christmas Tree

A YULE tree, whether it be the traditional green pine or a contemporary stylized form in pastel colors, silver or gold, is a timeless symbol of the Christmas Season. As a decoration indoors or outdoors, the Christmas tree today is made of many things: gleaming tinsel, colorful paper and foil, gay ribbons, sparkling ornaments, tinted plastic foam, delicate angel hair, to name but a few.

True, a Christmas tree may be many things, but to be symbolic there *must* be LIGHT!

A celestial contemporary tree, indeed! A string of multi-colored lights attached to a central post shine through spun glass held in place by graduated hoops suspended from ribbons and decorated with tinsel roping and ornaments. A gilded star-shaped base and a top ornament complete the ensemble.

Pink lights and pink tinsel roping on a wire frame silhouette this pastel tree against a dark wall in the festive corner shown at right.

Colorful lights backed by shiny reflectors peek through green slashed foil spiralled around a plastic cone to add gaiety to a child's party.

AUTHOR: Westinghouse Lamp Division, Bloomfield, N. J.

Is Many Things

By MYRTLE FAHSBENDER

A tree cut from white plastic foam, hung with colorful ornaments and mounted against a brilliant red background is floodlighted to create this study in contrasts.

Green roping forms the outline of a Christmas tree, at left, against the white brick wall, and strings of multicolored lights sparkle through the leaves, greeting guest and passerby alike.

Behind the cone-shaped tree are hung strings of multicolored bulbs which gleam through the "eyelid" designs. A floodlight accents the gold cardboard tree set in a frame of pine and lights.

A yellow star and strings of red and green lights form a tree at the rear of this hilltop house to beam Season's Greetings to the people in the valley below.

Illuminating Engineering Nomenclature And Photometric Standards

Prepared by the Nomenclature Committee of the Illuminating Engineering Society

Preface

Since the publication of ASA Z7.1-1942 "Illuminating Engineering Nomenclature and Photometric Standards," the Nomenclature Committee has been developing or revising segments of the Standard with the aim of eventually having a complete revision. As these segments, usually whole sections, are revised by the Committee, they are sent to Council for approval and publication.

This report presents the following sections which are to replace those with the corresponding numbers in the 1942 Standard:

Section 05. Photometric Quantities
Section 10. Radiation
Section 20. Color
Section 30. Characteristics of Surfaces and Media for Controlling Light
Section 50. Aeronautic Lighting

The remaining sections are now under revision. When all sections have been revised and published in ILLUMINATING ENGINEERING, it is intended that they all will be brought together into a single ASA report.

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C. L. Cottrell — W. F. Little
Harris Reinhardt

Section 05. Photometric Quantities

05.005. LIGHT: For the purposes of illuminating engineering, *light* is visually evaluated radiant energy.

Light is psychophysical, neither purely physical nor purely psychological. Light is not synonymous with radiant energy, however restricted, nor is it merely sensation. In a general, nonspecialized sense light is the aspect of radiant energy of which a human observer is aware through the visual sensations which arise from the stimulation of the retina of the eye.

The present basis for the engineering evaluation of light consists of the color-mixture data $\bar{x}$, $\bar{y}$, $\bar{z}$ adopted in 1931 by the International Commission on Illumination. These data include the relative luminosity data adopted in 1924 by the CIE.

05.010. LUMINOUS FLUX, F:* Luminous flux is the time rate of flow of light.

05.015. LUMEN, lm:* The lumen is the unit of luminous flux. It is equal to the flux through a unit solid angle (steradian) from a uniform point source of one candle, or to the flux on a unit surface all points of which are at unit distance from a uniform point source of one candle.

For some purposes the kilolumen, equal to 1000 lumens, is a convenient unit.

05.016. LUMINOUS FLUX DENSITY AT A SURFACE, dF/dA: Luminous flux density at a surface is luminous flux per unit area of the surface.

When referring to flux emitted from a surface, this is called *luminous emittance* (Symbol L). When referring to flux incident on a surface, it is identical with *illumination* (Symbol E) as defined in 05.035.

05.020. LUMINOUS INTENSITY, $I = dF/d\omega$:* Luminous intensity of a source of light in a given direction is the luminous flux per unit solid angle in the direction in question. Hence, it is the luminous flux on a small surface normal to that direction, divided by the solid angle (in steradians) which the surface subtends at the source.

Mathematically a solid angle must have a point as its apex; the definition of luminous intensity, therefore applies strictly only to a point source. In practice, however, light emanating from a source whose dimensions are negligible in comparison with the distance from which it is observed may be considered as coming from a point. For extended sources, see 25.065, Apparent Candlepower.

05.025. CANDLE, c: The candle is the unit of luminous intensity. One candle is defined as $^1/_{60}$th of the luminous intensity per square centimeter of a blackbody radiator operating at the temperature of solidification of platinum. Values for standards having other spectral distributions are derived by the use of accepted luminosity factors. (See 05.095 to 05.101.)

From 1909 until the introduction of the new photometric system on January 1, 1948, the unit of luminous intensity in the United States, as well as in France and Great Britain, was the "international candle" which was maintained by a group of carbon-filament vacuum lamps. For the newer unit as defined above, the CIE has recommended the name *candela*. In the United States the use of the term *candle* is being continued, and it now applies to the new unit as defined above. In the rare instances where the distinction is necessary, the terms *new candle* and *old candle* are used. The difference between the two is so small that only measurements of high precision are affected. (See National Bureau of Standards Letter Circular LC864.)

05.030. CANDLEPOWER, $I = dF/d\omega$; abbreviation, cp: Candlepower is luminous intensity expressed in candles. (See also 25.040 to 25.065.)

05.035. ILLUMINATION, $E = dF/dA$:* Illumination is the density of the luminous flux on a surface; it is the quotient of the flux by the area of the surface when the latter is uniformly illuminated.

The term illumination is also com-

Approved by the Council of the Illuminating Engineering Society: Sections 05 and 10, January 1951; Section 30, April 1955; Sections 20 and 50, Terms 05.016, 05.020, 05.065 and 10.025, July 1957. A Transaction of the I.E.S.

*For terms bearing this reference, the definitions given are substantially equivalent to definitions adopted by the International Commission on Illumination.

monly used in a qualitative or general sense to designate the act of illuminating or the state of being illuminated. Usually the context will indicate which meaning is intended, but occasionally it is desirable to use the expression *level of illumination* to indicate that the quantitative meaning is intended. (See *Transactions of the IES*, Vol. XXXIII, No. 2, p. 193, 1938.)

05.040. FOOTCANDLE, fc:* The footcandle is the unit of illumination when the foot is taken as the unit of length. It is the illumination on a surface one square foot in area on which there is a uniformly distributed flux of one lumen, or the illumination produced at a surface all points of which are at a distance of one foot from a uniform point source of one candle.

05.045. LUX, lx:* The lux is the practical unit of illumination in the metric system, and is equivalent to the "metercandle." It is the illumination on a surface one square meter in area on which there is a uniformly distributed flux of one lumen, or the illumination produced at a surface all points of which are at a distance of one meter from a uniform point source of one candle.

05.050. PHOT, ph:* The phot is the unit of illumination when the centimeter is taken as the unit of length; it is equal to one lumen per square centimeter.

1 Footcandle = 10.764 Lux = 1.0764 milliphot. (See Section 90, Equivalents and Conversion Factors.)

05.055. QUANTITY OF LIGHT (LUMINOUS ENERGY), $Q = \int F dt$: Quantity of light (luminous energy) is the product of the luminous flux by the time it is maintained. It is the time integral of luminous flux. (Compare 05.005. and 05.010.)

05.060. LUMEN-HOUR, lm-hr: The lumen-hour is the unit of quantity of light (luminous energy). It is the quantity of light (luminous energy) delivered in one hour by a flux of one lumen.

05.061. LUMINOUS DENSITY, $q = dQ/dV$: Luminous density is quantity of light (luminous energy) per unit volume.

05.065. PHOTOMETRIC BRIGHTNESS (LUMINANCE), $B = d^2F/d\omega\,(dA\cos\theta) = dI/(dA\cos\theta)$: Photometric brightness (luminance) is the luminous flux per unit of projected area per unit solid angle either leaving a surface at a given point in a given direction or arriving at a given point from a given direction; or it is the luminous intensity of any surface in a given direction per unit of projected area of the surface as viewed from that direction.

In the defining equation θ is the angle between the direction of observation and the normal to the surface.

In common usage the term brightness usually refers to the intensity of *sensation* which results from viewing surfaces or spaces from which light comes to the eye. This sensation is determined in part by the definitely measurable "photometric brightness" defined above and in part by conditions of observation such as the state of adaptation of the eye.

05.070. UNITS OF PHOTOMETRIC BRIGHTNESS (LUMINANCE): Photometric brightness (luminance) of a surface in a specified direction may be expressed in luminous intensity per unit area of surface.

A typical unit in this system is the candle per square inch.

Photometric brightness (luminance) of a surface in a specified direction may also be expressed in terms of the number of lumens per unit area which would be emitted by the surface if the brightness in all directions within the hemisphere on the side of the surface being considered were the same as the brightness in the specified direction.

A typical unit in this system is the footlambert, equivalent to one lumen per square foot.

This method of specifying photometric brightness is equivalent to stating the number of lumens which would be emitted if the surface were replaced by a perfectly diffusing surface with a photometric brightness in all directions within the hemisphere equal to the photometric brightness of the actual surface in the direction specified. In practice no surface follows exactly the cosine formula of emission or reflection; hence the photometric brightness (luminance) is not uniform but varies with the angle from which it is viewed.

The average photometric brightness (average luminance) of a surface may be expressed in terms of the total lumens actually emitted from the surface per unit area. Average photometric brightness (average luminance) specified in this way is identical in magnitude with luminous emittance (05.016).

In general, the concept of average photometric brightness (average luminance) is useful only when the photometric brightness (luminance) is reasonably uniform throughout a very wide angle of observation and over a large area of the surface considered. It has the advantage that it can be readily computed for reflecting surfaces by multiplying the incident luminous flux density (illumination) by the luminous reflectance of the surface. For a transmitting body it can be computed by multiplying the incident luminous flux density by the luminous transmittance of the body.

05.075. STILB, sb:* The stilb is a unit of photometric brightness (luminance) equal to one candle per square centimeter.

The name stilb has been adopted by the International Commission on Illumination and is commonly used in European publications. In America the preferred practice is to use self-explanatory terms such as candle per square inch and candle per square centimeter.

05.080. LAMBERT, L: The lambert is a unit of photometric brightness (luminance) equal to $1/\pi$ candle per square centimeter, and, therefore, is equal to the uniform photometric brightness (luminance) of a perfectly diffusing surface emitting or reflecting light at the rate of one lumen per square centimeter.

The lambert is also the average photometric brightness (luminance) of any surface emitting or reflecting light at the rate of one lumen per square centimeter. For the general case the average must take account of variation of photometric brightness (luminance) with angle of observation and also of its variation from point to point on the surface considered.

05.085. FOOTLAMBERT, fL: The footlambert is a unit of photometric brightness (luminance) equal to $1/\pi$ candle per square foot, or to the uniform photometric brightness (luminance) of a perfectly diffusing surface emitting or reflecting light at the rate of one lumen per square foot, or to the average photometric brightness (luminance) of any surface emitting or reflecting light at that rate.

The average photometric brightness

*For terms bearing this reference, the definitions given are substantially equivalent to definitions adopted by the International Commission on Illumination.

TABLE I — Relative Luminosity Factors.
(Unity at Wavelength of Maximum Luminosity)

λ in mμ	Standard factors	Values interpolated at intervals of one millimicron								
		1	2	3	4	5	6	7	8	9
380	0.00004	0.000045	0.000049	0.000054	0.000059	0.000064	0.000071	0.000080	0.000090	0.000104
390	.00012	.000138	.000155	.000173	.000193	.000215	.000241	.000272	.000308	.000350
400	.0004	.00045	.00049	.00054	.00059	.00064	.00071	.00080	.00090	.00104
410	.0012	.00138	.00156	.00174	.00195	.00218	.00244	.00274	.00310	.00352
420	.0040	.00455	.00515	.00581	.00651	.00726	.00806	.00889	.00976	.01066
430	.0116	.01257	.01358	.01463	.01571	.01684	.01800	.01920	.02043	.02170
440	.023	.0243	.0257	.0270	.0284	.0298	.0313	.0329	.0345	.0362
450	.038	.0399	.0418	.0438	.0459	.0480	.0502	.0525	.0549	.0574
460	.060	.0627	.0654	.0681	.0709	.0739	.0769	.0802	.0836	.0872
470	.091	.0950	.0992	.1035	.1080	.1126	.1175	.1225	.1278	.1333
480	.139	.1448	.1507	.1567	.1629	.1693	.1761	.1833	.1909	.1991
490	.208	.2173	.2270	.2371	.2476	.2586	.2701	.2823	.2951	.3087
500	.323	.3382	.3544	.3714	.3890	.4073	.4259	.4450	.4642	.4836
510	.503	.5229	.5436	.5648	.5865	.6082	.6299	.6511	.6717	.6914
520	.710	.7277	.7449	.7615	.7776	.7932	.8082	.8225	.8363	.8495
530	.862	.8739	.8851	.8956	.9056	.9149	.9238	.9320	.9398	.9471
540	.954	.9604	.9661	.9713	.9760	.9803	.9840	.9873	.9902	.9928
550	.995	.9969	.9983	.9994	1.0000	1.0002	1.0001	.9995	.9984	.9969
560	.995	.9926	.9898	.9865	9828	.9786	.9741	.9691	.9638	.9581
570	.952	.9455	.9386	.9312	.9235	.9154	.9069	.8981	.8890	.8796
580	.870	.8600	.8496	.8388	.8277	.8163	.8046	.7928	.7809	.7690
590	.757	.7449	.7327	.7202	.7076	.6949	.6822	.6694	.6565	.6437
600	.631	.6182	.6054	.5926	.5797	.5668	.5539	.5410	.5282	.5156
610	.503	.4905	.4781	.4658	.4535	.4412	.4291	.4170	.4049	.3929
620	.381	.3690	.3570	.3449	.3329	.3210	.3092	.2977	.2864	.2755
630	.265	.2548	.2450	.2354	.2261	.2170	.2082	.1996	.1912	.1830
640	.175	.1672	.1596	.1523	.1452	.1382	.1316	.1251	.1188	.1128
650	.107	.1014	.0961	.0910	.0862	.0816	.0771	.0729	.0688	.0648
660	.061	.0574	.0539	.0506	.0475	.0446	.0418	.0391	.0366	.0343
670	.032	.0299	.0280	.0263	.0247	.0232	.0219	.0206	.0194	.0182
680	.017	.01585	.01477	.01376	.01281	.01192	.01108	.01030	.00956	.00886
690	.0082	.00759	.00705	.00656	.00612	.00572	.00536	.00503	.00471	.00440
700	.0041	.00381	.00355	.00332	.00310	.00291	.00273	.00256	.00241	.00225
710	.0021	.001954	.001821	.001699	.001587	.001483	.001387	.001297	.001212	.001130
720	.00105	.000975	.000907	.000845	.000788	.000736	.000688	.000644	.000601	.000560
730	.00052	.000482	.000447	.000415	.000387	.000360	.000335	.000313	.000291	.000270
740	.00025	.000231	.000214	.000198	.000185	.000172	.000160	.000149	.000139	.000130
750	.00012	.000111	.000103	.000096	.000090	.000084	.000078	.000074	.000069	.000064
760	.00006	.000056	.000052	.000048	.000045	.000042	.000039	.000037	.000035	.000032

(luminance) of any reflecting surface in footlamberts is, therefore, the product of the illumination in footcandles by the luminous reflectance of the surface.

The footlambert is the same as the "apparent footcandle."

05.090. PHOTOMETRIC BRIGHTNESS RATIO (LUMINANCE RATIO): Photometric brightness ratio (luminance ratio) is the ratio of the photometric brightnesses (luminances) of any two surfaces.

05.095. LUMINOSITY FACTOR, $K = F_\lambda / P_\lambda$:*,† The luminosity factor for radiation of a particular wavelength is the ratio of the luminous flux at that wavelength to the corresponding radiant flux. (See 10.015.) It is expressed in lumens per watt.

05.100. RELATIVE LUMINOSITY FACTOR:*,† The relative luminosity factor for a particular wavelength is the ratio of the luminosity factor for that wavelength to the value at the wavelength of maximum luminosity.

05.101. VALUES OF LUMINOSITY FACTORS:*,† The values for relative luminosity factors, given at 10-millimicron intervals in column two of Table I, have been adopted by the International Commission on Illumination and the International Committee on Weights and Measures as the basis for establishment of photometric standards of types differing from the primary standard in spectral distribution of light. The intermediate values given in other columns have been interpolated.

The standard luminosity factors were determined by observations with a small photometric field having a moderately high brightness, and photometric evaluations based upon them consequently do not apply exactly to other conditions of observation. In special cases which are concerned with the end regions of the spectrum or with peculiar conditions of field size, intensity, etc., care should be taken to select and use factors which correspond to the particular conditions.

05.105. LUMINOUS EFFICIENCY: The luminous efficiency of radiant energy is the ratio of the luminous flux to the radiant flux.

Luminous efficiency is usually expressed in lumens per watt of radiant flux. It should not be confused with the term efficiency as applied to a practical source of light (see 25.020), since the latter is based upon the power supplied to the source instead of the radiant flux from the source.

For energy radiated at a single wavelength, luminous efficiency is synonymous with luminosity factor (05.095).

The reciprocal of the luminous efficiency of radiant energy is sometimes called the "mechanical equivalent of light." The value most commonly cited is the *minimum* "mechanical equivalent," that is, the watts per lumen at the wavelength of maximum luminosity. The most probable value is 0.00147 watt per lumen, corresponding to 680 lumens per watt as the maximum possible efficiency of a source of light. These values are based on the candle as defined in 05.025, on the standard CIE luminosity factors given in Table I, and on the 1948 International Temperature Scale by using Planck's equation with $c_2 = 1.438$ cm deg K, $c_{1N} = 1.189 \times 10^{-12}$ watt cm^2, and 2042 K as the temperature of freezing platinum.

*For terms bearing this reference, the definitions given are substantially equivalent to definitions adopted by the International Commission on Illumination.
†In these terms *luminosity* replaces the word *visibility* formerly used.

Section 10. Radiation

10.005. RADIANT ENERGY, U: Radiant energy is energy traveling in the form of electromagnetic waves. It is measured in units of energy such as ergs, joules, calories, or kilowatthours.

10.010. SPECTRAL RADIANT ENERGY, $U_\lambda = dU/d\lambda$: Spectral radiant energy is radiant energy per unit wavelength interval at wavelength λ, *e.g.*, ergs/micron.

10.015. RADIANT FLUX, $P = dU/dt$: Radiant flux is the time rate of flow of radiant energy. It is expressed preferably in watts, or in ergs per second.

10.020. RADIANT DENSITY, $u = dU/dV$: Radiant density is radiant energy per unit volume; *e.g.*, ergs/cm^3.

10.025. RADIANT DENSITY AT A SURFACE, dP/dA: Radiant flux density at an element of surface is the ratio of radiant flux at that element of surface to the area of that element; *e.g.*, watts/cm^2. When referring to radiant flux emitted from a surface, this is called *radiant emittance* (Symbol W). When referring to radiant flux incident on a surface, it is called *irradiance* (Symbol H).

10.030. RADIANT INTENSITY, $J = dP/d\omega$: The radiant intensity of a source is the energy emitted per unit time, per unit solid angle about the direction considered; *e.g.*, watts/steradian.

10.035. SPECTRAL RADIANT INTENSITY, $J_\lambda = dJ/d\lambda$: Spectral radiant intensity is radiant intensity per unit wavelength interval; *e.g.*, watts/(steradian, micron).

10.040. RADIANCE, $N = d^2P/d\omega\,(dA\cos\theta) = dJ/(dA\cos\theta)$: Radiance of an element of a source in any direction is the radiant flux per unit solid angle per unit of projected area of the element of source as observed from that direction. It is equivalent to the radiant intensity per unit of projected area of the source.

In the defining equation θ is the angle between the normal to the element of source and the direction of observation.

10.050. TEMPERATURE RADIATOR: A temperature radiator is one whose radiant flux density (radiant emittance) is determined by its temperature and the material and character of its surface, and is independent of its previous history.

10.055. BLACKBODY: A blackbody is a temperature radiator of uniform temperature whose radiant emittance in all parts of the spectrum is the maximum obtainable from any temperature radiator at the same temperature.

Such a radiator is called a blackbody because it will absorb all the radiant energy that falls upon it. All other temperature radiators may be classed as non-blackbodies. They radiate less in some or all wavelength intervals than a blackbody of the same size and the same temperature.

The blackbody is practically realized in the form of a cavity with opaque walls at uniform temperature and with a small opening for observation purposes. It is variously called standard radiator, or ideal radiator.

10.060. TOTAL EMISSIVITY, ε_t: The total emissivity of an element of surface of a temperature radiator is the ratio of its radiant flux density (radiant emittance) to that of a blackbody at the same temperature.

10.065. SPECTRAL EMISSIVITY, ε_λ: The spectral emissivity of an element of surface of a temperature radiator at any wavelength is the ratio of its radiant flux density per unit wavelength interval (spectral radiant emittance), at that wavelength, to that of a blackbody at the same temperature.

10.070. GRAYBODY: A graybody is a temperature radiator whose spectral emissivity is less than unity and the same at all wavelengths.

10.075. STEFAN-BOLTZMANN LAW: The Stefan-Boltzmann law is the statement that the emitted radiant flux density (or radiant emittance) of a blackbody is proportional to the fourth power of its absolute temperature; that is

$$W = \sigma T^4$$

Selected experimental values of the constant σ, called the Stefan-Boltzmann constant, average about 5.76×10^{-12} watt cm^{-2} deg K^{-4}.

The most recent review of the atomic constants (DuMond and Cohen, *Rev. Mod. Phys. 20*, 82, 1948) gives a derived value, 5.6724×10^{-12} which is probably more accurate.

10.080. PLANCK RADIATION LAW: The Planck radiation law is an expression representing the spectral radiant intensity of a blackbody as a function of the wavelength (or the frequency) and temperature. This law is commonly expressed by the formula:

$$J_\lambda/A' = N_\lambda = c_{1N}\lambda^{-5}\,(e^{(c_2/\lambda T)} - 1)^{-1}$$

in which J_λ represents the spectral radiant intensity, A' is the projected area ($A\cos\theta$) of the aperture of the blackbody, e is the base of natural logarithms 2.718+, T is absolute temperature, c_{1N} and c_2 are constants designated as the first and second radiation constants.

The designation c_{1N} is used to indicate that the equation in the form here given refers to the intensity J, or to the radiance, N, of the source. Numerical values commonly given for c_1 apply to energy radiated in a hemisphere, so that $c_1 = \pi c_{1N}$.

The value of c_2 adopted by the International Temperature Scale of 1948 is 1.438 cm deg K. With the quantities defined as above, power being expressed in watts and all lengths in centimeters,

$$c_{1N} = 15\pi^{-5}c_2{}^4\sigma.$$

Then if $c_2 = 1.438$ and $\sigma = 5.6724 \times 10^{-12}$, $c_{1N} = 1.189 \times 10^{-12}$ watt cm^2. If wavelengths are expressed in microns, and area in square centimeters, $c_{1N} = 1.189 \times 10^4$, J_λ being given in watts per steradian per micron.

The Planck law in the following form in which c_1 is π times c_{1N} as given above, shows the energy radiated from the blackbody in a given wavelength interval:

$$U = U_\lambda\,d\lambda$$
$$= A\cdot t\cdot c_1\lambda^{-5}\,(e^{(c_2/\lambda T)} - 1)^{-1}\,d\lambda$$

If A is area of the radiation aperture or surface in square centimeters, t is time in seconds, λ is wavelength in microns, and $c_1 = 3.735 \times 10^4$ watt micron^4 cm^{-2}, then $U_\lambda d\lambda$ is energy in watt seconds, emitted from this area, in time t, in the solid angle 2π, within the wavelength interval $d\lambda$ at wavelength λ.

It is often convenient, as is done here, to use different units of length in specifying wavelengths and areas, respectively. If both quantities are expressed in centimeters and the corresponding value for c_1 (3.735×10^{-5} erg cm^2 sec^{-1}) is used, this equation gives the emission of energy in ergs from area A in the solid angle 2π, at wavelength λ, for time t, and for the interval $d\lambda$ in centimeters.

10.085. WIEN RADIATION LAW: The Wien radiation law is an expression representing approximately the spectral radiant intensity of a blackbody as a function of its wavelength (or

TABLE II — Wavelength Units.

Name	Abbreviation	Value
Micron	μ	$1\mu = 10^{-3}$ mm
Millimicron	mμ	$1\text{m}\mu = 10^{-6}$ mm
Angstrom	Å	$1\text{Å} = 10^{-7}$ mm
X-Unit	XU	$1\text{XU} = 10^{-10}$ mm

frequency) and temperature. It is commonly expressed by the formula:

$$J_\lambda/A' = N_\lambda = c_{1N}\lambda^{-5}e^{-(c_2/\lambda T)}.$$

This law is accurate to 1 per cent or better for values of λT less than 3000 micron degrees Kelvin.

10.090. WIEN DISPLACEMENT LAW: The Wien displacement law is an expression representing, in a functional form, the spectral radiant intensity of a blackbody as a function of the wavelength (or frequency) and the temperature.

$$J_\lambda/A' = N_\lambda = c_1\lambda^{-5}f(\lambda T).$$

The two principal corollaries of this law are:

$$\lambda_m T = \text{constant}$$
$$J_m/(A'T^5) = \text{constant}$$

which show how the maximum spectral radiant intensity J_m, and the wavelength λ_m at which it occurs, are related to the absolute temperature T.

A' is the projected area of the radiating aperture. The above corollaries are also derivable from the Planck radiation law, the constants having slightly different forms in this case. From the Planck radiation law,

$$\lambda_m T = c_2/4.9651 \quad \text{and}$$
$$J_m/(A'T^5) = 21.202\, c_{1N}/c_2{}^5.$$

Adopting the values $c_2 = 1.438$ cm deg from the International Temperature Scale of 1948 and $c_{1N} = 1.189 \times 10^{-5}$ erg cm^2 sec^{-1} (see 10.080) gives $\lambda_m T = 0.2896$ cm deg and $J_m/(A'T^5) = 4.10 \times 10^{-12}$ watt cm^{-3} steradian^{-1} deg^{-5}.

10.095. UNITS OF WAVELENGTH: Spectral radiant-energy measurements necessitate some statement as to the unit of wavelength used, since four different units are in use, as shown in Table II.

Section 20. Color

Additional definitions relating to color and colorimetry will be found in American Standard Nomenclature and Definitions in the Field of Colorimetry, ASA Z58.1.2.

20.005. COLOR: Color consists of the characteristics of light determined by its spectral composition and the spectral properties of the average normal human eye.

20.006. COLOR OF AN OBJECT: The color of an object is the color of the light reflected or transmitted by it when illuminated by a standard light source such as CIE source A, B, or C.

20.006.1. PERCEIVED OBJECT COLOR: Perceived object color is the color perceived to belong to an object, resulting from characteristics of the object, of the incident light, and of the surround, the viewing direction, and observer adaptation.

20.006.2. HUE OF A PERCEIVED OBJECT COLOR: Hue of a perceived object color is the attribute which determines whether it is red, yellow, green, blue, or the like.

20.006.3. SATURATION OF A PERCEIVED OBJECT COLOR: Saturation of a percieved object color is the attribute used to describe its departure from gray of the same lightness.

20.006.4. LIGHTNESS OF A PERCEIVED OBJECT COLOR: Lightness of a perceived object color is the attribute by which the object seems to transmit or reflect a greater or lesser fraction of the incident light.

20.006.5. MUNSELL COLOR SYSTEM: The Munsell color system is a system of surface-color specification based on perceptually uniform color scales for the three variables: Munsell hue, Munsell value, and Munsell chroma. For an observer of normal color vision, adapted to daylight and viewing the specimen illuminated by daylight surrounded with a middle gray to white background, the Munsell hue, value, and chroma of the color correlate well with the hue, lightness, and saturation of the perceived color.

20.006.6. MUNSELL HUE, H: Munsell hue is the index of the hue of the perceived object color defined** in terms of the Y-value and chromaticity coordinates (x, y) of the color of the light reflected or transmitted by the object.

20.006.7. MUNSELL VALUE, V: Munsell value is the index of the lightness of the perceived object color defined** in terms of the Y-value.

Munsell value is approximately equal to the square root of the brightness (luminance) factor expressed in per cent.

20.006.8. MUNSELL CHROMA, C: Munsell chroma is the index of saturation of the perceived object color defined** in terms of the Y-value and chromaticity coordinates (x, y) of the color of the light reflected or transmitted by the object.

20.007. COLOR OF A LIGHT SOURCE: The color of a light source consists of the characteristics of the source determined by its spectral composition and the spectral properties of the average normal human eye.

20.007.1. PERCEIVED LIGHT-SOURCE COLOR: Perceived light-source color is the color perceived to belong to a light source.

20.007.2. HUE OF A PERCEIVED LIGHT-SOURCE COLOR: Hue of a perceived light-source color is the attribute which determines whether it is red, yellow, green, blue, or the like.

20.007.3. SATURATION OF A PERCEIVED LIGHT-SOURCE COLOR: Saturation of a perceived light-source color is the attribute used to describe its departure from a light-source color of the same brightness perceived to have no hue.

20.007.4. BRIGHTNESS OF A PERCEIVED LIGHT-SOURCE COLOR: Brightness of a perceived light-source color is the attribute in accordance with which the source seems to emit more or less luminous flux per unit area.

20.007.5. COLOR TEMPERATURE OF A LIGHT SOURCE: The color temperature of a light source is the temperature at which a blackbody radiator must be operated to have a chromaticity equal to that of the light source.

20.008. METAMERS: Metamers are lights of the same color but of different spectral energy distribution.

20.009. DOMINANT WAVELENGTH OF A LIGHT, λ_d: Dominant wavelength of a light is the wavelength of radiant energy of a single frequency which matches the color of the light when combined in suitable proportion with the radiant energy of the reference standard.

20.010. COMPLEMENTARY WAVELENGTH OF A LIGHT, λ_c: Complementary wavelength of a light is the wave-

**See *Journal of the Optical Society of America*, Vol. 33, p. 385, 1943.

TABLE III — Spectral Tristimulus Values for Equal-Energy Source. 1931 CIE Standard Observer.

Wavelength ($m\mu$)	$\bar{x}$	$\bar{y}$	$\bar{z}$	Wavelength ($m\mu$)	$\bar{x}$	$\bar{y}$	$\bar{z}$
380	0.0014	0.0000	0.0065	580	0.9163	0.8700	0.0017
385	0.0022	0.0001	0.0105	585	0.9786	0.8163	0.0014
390	0.0042	0.0001	0.0201	590	1.0263	0.7570	0.0011
395	0.0076	0.0002	0.0362	595	1.0567	0.6949	0.0010
400	0.0143	0.0004	0.0679	600	1.0622	0.6310	0.0008
405	0.0232	0.0006	0.1102	605	1.0456	0.5668	0.0006
410	0.0435	0.0012	0.2074	610	1.0026	0.5030	0.0003
415	0.0776	0.0022	0.3713	615	0.9384	0.4412	0.0002
420	0.1344	0.0040	0.6456	620	0.8544	0.3810	0.0002
425	0.2148	0.0073	1.0391	625	0.7514	0.3210	0.0001
430	0.2839	0.0116	1.3856	630	0.6424	0.2650	0.0000
435	0.3285	0.0168	1.6230	635	0.5419	0.2170	0.0000
440	0.3483	0.0230	1.7471	640	0.4479	0.1750	0.0000
445	0.3481	0.0298	1.7826	465	0.3608	0.1382	0.0000
450	0.3362	0.0380	1.7721	650	0.2835	0.1070	0.0000
455	0.3187	0.0480	1.7441	655	0.2187	0.0816	0.0000
460	0.2908	0.0600	1.6692	660	0.1649	0.0610	0.0000
465	0.2511	0.0739	1.5281	665	0.1212	0.0446	0.0000
470	0.1954	0.0910	1.2876	670	0.0874	0.0320	0.0000
475	0.1421	0.1126	1.0419	675	0.0636	0.0232	0.0000
480	0.0956	0.1390	0.8130	680	0.0468	0.0170	0.0000
485	0.0580	0.1693	0.6162	685	0.0329	0.0119	0.0000
490	0.0320	0.2080	0.4652	690	0.0227	0.0082	0.0000
495	0.0147	0.2586	0.3533	695	0.0158	0.0057	0.0000
500	0.0049	0.3230	0.2720	700	0.0114	0.0041	0.0000
505	0.0024	0.4073	0.2123	705	0.0081	0.0029	0.0000
510	0.0093	0.5030	0.1582	710	0.0058	0.0021	0.0000
515	0.0291	0.6082	0.1117	715	0.0041	0.0015	0.0000
520	0.0633	0.7100	0.0782	720	0.0029	0.0010	0.0000
525	0.1096	0.7932	0.0573	725	0.0020	0.0007	0.0000
530	0.1655	0.8620	0.0422	730	0.0014	0.0005	0.0000
535	0.2257	0.9149	0.0298	735	0.0010	0.0004	0.0000
540	0.2904	0.9540	0.0203	740	0.0007	0.0003	0.0000
545	0.3597	0.9803	0.0134	745	0.0005	0.0002	0.0000
550	0.4334	0.9950	0.0087	750	0.0003	0.0001	0.0000
555	0.5121	1.0002	0.0057	755	0.0002	0.0001	0.0000
560	0.5945	0.9950	0.0039	760	0.0002	0.0001	0.0000
565	0.6784	0.9786	0.0027	765	0.0001	0.0000	0.0000
570	0.7621	0.9520	0.0021	770	0.0001	0.0000	0.0000
575	0.8425	0.9154	0.0018	775	0.0000	0.0000	0.0000
580	0.9163	0.8700	0.0017	780	0.0000	0.0000	0.0000
		Totals:	$X = 21.3713$	$Y = 21.3714$		$Z = 21.3715$	

length of radiant energy of a single frequency which matches the color of the reference standard when combined in suitable proportion with the light.

20.011. COLORIMETRIC PURITY OF A LIGHT, p_c: Colorimetric purity of a light is the ratio B_1/B_2 where B_1 is the photometric brightness (luminance) of the single frequency component which must be mixed with the reference standard to match the color of the light and B_2 is the photometric brightness (luminance) of the light.

20.012. EXCITATION PURITY OF A LIGHT, p_e: Excitation purity of a light is the ratio of the distance on the CIE chromaticity diagram between the reference point and the light point to the distance in the same direction between the reference point and the spectrum locus or the purple boundary.

20.013. CHROMATICITY OF A COLOR: Chromaticity of a color consists of the dominant or complementary wavelength and purity aspects of the color taken together, or of the aspects specified by the chromaticity coordinates of the color taken together.

20.013.1. CHROMATICITY COORDINATES OF A LIGHT, x, y, z: Chromaticity coordinates of a light are the ratios of each of the tristimulus values of the light to the sum of the three tristimulus values.

20.014. TRISTIMULUS VALUES OF A LIGHT, X, Y, Z: Tristimulus values of a light are the amounts of each of three primaries required to match the color of the light.

20.014.1. SPECTRAL TRISTIMULUS VALUES, $\bar{x}_\lambda = dX/dP d\lambda$, $\bar{y}_\lambda = dY/dP d\lambda$, $\bar{z}_\lambda = dZ/dP d\lambda$: Spectral tristimulus values are the tristimulus values per unit wavelength interval per unit radiant flux of the colors of the spectrum.

20.015. PRIMARY: A primary is any one of three lights in terms of which a color is specified by giving the amounts required to duplicate it by additive combination.

20.016. CHROMATICITY DIAGRAM: A chromaticity diagram is a plane diagram formed by plotting one of the three chromaticity coordinates against another.

20.016.1. SPECTRUM LOCUS: The spectrum locus is the locus of points representing the colors of the visible spectrum in a chromaticity diagram.

20.016.2. PURPLE BOUNDARY: The purple boundary is the straight line drawn between the ends of the spectrum locus on a chromaticity diagram.

20.016.3. BLACKBODY (PLANCKIAN) LOCUS: The blackbody locus is the locus of points on a chromaticity diagram representing the chromaticities of blackbodies having various temperatures.

Section 30. Characteristics of Surfaces and Media for Controlling Light

30.005. DIFFUSING SURFACES AND MEDIA: Diffusing surfaces and media are those that redistribute some of the

TABLE IV — Tristimulus Computational Data for CIE Standard Illuminants A and C. 1931 CIE Standard Observer.

Wavelength ($m\mu$)	CIE Standard Illuminant A Planck 2850 K, $c_2 = 1.436$			CIE Standard Illuminant C		
	$\bar{x}P$	$\bar{y}P$	$\bar{z}P$	$\bar{x}P$	$\bar{y}P$	$\bar{z}P$
380	1		6	4		20
390	5		23	19		89
400	19	1	93	85	2	404
410	71	2	340	329	9	1,570
420	262	8	1,256	1,238	37	5,949
430	649	27	3,167	2,997	122	14,628
440	926	61	4,647	3,975	262	19,938
450	1,031	117	5,435	3,915	443	20,638
460	1,019	210	5,851	3,362	694	19,299
470	776	362	5,116	2,272	1,058	14,972
480	428	622	3,636	1,112	1,618	9,461
490	160	1,039	2,324	363	2,358	5,274
500	27	1,792	1,509	52	3,401	2,864
510	57	3,080	969	89	4,833	1,520
520	425	4,771	525	576	6,462	712
530	1,214	6,322	309	1,523	7,934	388
540	2,313	7,600	162	2,785	9,149	195
550	3,732	8,568	75	4,282	9,832	86
560	5,510	9,222	36	5,880	9,841	39
570	7,571	9,457	21	7,322	9,147	20
580	9,719	9,228	18	8,417	7,992	16
590	11,579	8,540	12	8,984	6,627	10
600	12,704	7,547	10	8,949	5,316	7
610	12,669	6,356	4	8,325	4,176	2
620	11,373	5,071	3	7,070	3,153	2
630	8,980	3,704		5,309	2,190	
640	6,558	2,562		3,693	1,443	
650	4,336	1,637		2,349	886	
660	2,628	972		1,361	504	
670	1,448	530		708	259	
680	804	292		369	134	
690	404	146		171	62	
700	209	75		82	29	
710	110	40		39	14	
720	57	19		19	6	
730	28	10		8	3	
740	14	6		4	2	
750	6	2		2	1	
760	4	2		1	1	
770	2			1		
Totals	$X = 109.828$	$Y = 100.000$	$Z = 35.547$	$X = 98.041$	$Y = 100.000$	$Z = 118.103$
	$x = 0.4476$	$y = 0.4075$		$x = 0.3101$	$y = 0.3163$	

incident flux by scattering in all directions.

30.010. PERFECT DIFFUSION: Perfect diffusion is that in which flux is scattered in accord with Lambert's Cosine Law. See 30.010.1.

30.010.1. LAMBERT'S COSINE LAW, $I_\theta = I_o \cos\theta$: The flux per solid angle in any direction from a plane surface varies as the cosine of the angle between that direction and the perpendicular to the surface.

30.011. COMPLETE DIFFUSION: Complete diffusion is that in which the diffusing medium re-emits some of the flux incident upon it so that none is in an image-forming state.

30.012. INCOMPLETE DIFFUSION: Incomplete (partial) diffusion is that in which the diffusing medium re-emits some of the flux incident upon it in an image-forming state and another portion in a non-image-forming state.

30.020. WIDE ANGLE DIFFUSION: Wide angle diffusion is that in which flux is scattered at angles far from the direction which the flux would take by regular reflection or transmission.

30.025. NARROW ANGLE DIFFUSION: Narrow angle diffusion is that in which flux is scattered at angles near the direction which the flux would take by regular reflection or transmission.

30.040. REDIRECTING SURFACES AND MEDIA: Redirecting surfaces and media are those which change the direction of the flux without scattering the redirected flux.

30.041. REFLECTION: Reflection is a general term for the process by which a part of the incident flux leaves a surface or medium from the incident side.

Reflection is usually a combination of regular (30.042) and diffuse (30.043) reflection.

30.042. REGULAR (SPECULAR) REFLECTION: Regular (specular) reflection is that process by which a portion of the incident flux is re-emitted at the specular angle without scattering. See 30.042.1.

30.042.1. SPECULAR ANGLE: Specular angle is that angle between the perpendicular to the surface and the reflected ray that is numerically equal to the angle of incidence and that lies in the same plane as the incident ray and the perpendicular but on the opposite side of the perpendicular to the surface.

30.043. DIFFUSE REFLECTION: Diffuse reflection is that process by which a portion of the incident flux is re-emitted in a non-image forming (diffused) state.

30.044. REFLECTANCE, $\rho = F_r/F_i$: The reflectance of a surface or medium is the ratio of the reflected flux to the incident flux.

Measured values of reflectance depend upon the angles of incidence and view and on the spectral character of the incident flux. Because of this dependence the angles of incidence and view and the spectral characteristics of the source should be specified.

30.044.1. TOTAL REFLECTANCE: Total reflectance is the ratio of the total flux leaving a surface or medium by reflection to the incident flux.

30.044.2. Regular (Specular) Reflectance: Regular reflectance is the ratio of the flux leaving a surface or medium by regular (specular) reflection to the incident flux.

30.044.3. Diffuse Reflectance: Diffuse reflectance is the ratio of the flux leaving a surface or medium by diffuse reflection to the incident flux.

30.044.4. Spectral Reflectance, $\rho_\lambda = (F_r)_\lambda/(F_i)_\lambda$: The spectral reflectance of a surface or medium is the ratio of the reflected flux to the incident flux at a particular wavelength, λ, or within a small band of wavelengths, $\Delta\lambda$, about λ.

The terms *total, regular,* or *diffuse reflectance* may each be considered restricted to a specific region of the spectrum and may be so designated as "spectral."

30.050. Transmission: Transmission is a general term for the process by which a part of the incident flux leaves a surface or medium on a side other than the incident side.

Transmission through a medium is often a combination of regular (30.051) and diffuse (30.052) transmission.

30.051. Regular Transmission: Regular transmission is that process by which a portion of the incident flux is re-emitted from a surface or medium on the non-incident side without scattering (no diffusion).

30.052. Diffuse Transmission: Diffuse transmission is that process by which a portion of the incident flux is re-emitted from a surface or medium on the non-incident side in a non-image-forming (diffused) state.

30.053. Transmittance, $\tau = F_t/F_i$: The transmittance of a medium is the ratio of the transmitted flux to the incident flux.

Measured values of transmittance depend upon the angle of incidence, the method of measurement of the transmitted flux, and the spectral character of the incident flux. Because of this dependence complete information on the technique and conditions of measurement should be specified.

It should be noted that transmittance refers to the ratio of flux emerging to flux incident; therefore, reflections at the surface as well as absorption within the material operate to reduce the transmittance.

30.053.1. Total Transmittance: Total transmittance is the ratio of the total transmitted flux leaving a surface or medium to the incident flux.

30.053.2. Regular Transmittance: Regular transmittance is the ratio of the regularly transmitted flux leaving a surface or medium to the incident flux.

30.053.3. Diffuse Transmittance: Diffuse transmittance is the ratio of the diffusely transmitted flux leaving a surface or medium to the incident flux.

30.053.4. Spectral Transmittance, $\tau_\lambda = (F_t)_\lambda/(F_i)_\lambda$: The spectral transmittance of a medium is the ratio of the transmitted flux to the incident flux at a particular wavelength, λ, or within a small band of wavelengths, $\Delta\lambda$, about λ.

The terms *total, regular* or *diffuse transmittance* may each be considered restricted to a specific region of the spectrum and may be so designated as "spectral."

30.060. Absorption: Absorption is a general term for the process by which a part of the incident flux at a surface or medium is dissipated within the medium.

All of the incident flux is accounted for by the processes of reflection, transmission and absorption.

30.061. Absorptance, $\alpha = F_a/F_i$: The absorptance of a medium is the ratio of the absorbed flux to the incident flux.

The sum of the total reflectance, the total transmittance, and the absorptance is 1.

30.062. Coefficient of Attenuation, γ: The coefficient of attenuation is the decrement in flux per unit distance in a given direction within a medium and is defined by the relation: $F_x = F_o e^{-\gamma x}$ where F_x is the flux at any distance x from a reference point having flux F_o.

30.070. Brightness (Luminance) Factor: Brightness (luminance) factor is the ratio of the photometric brightness of a surface or medium under specified conditions of incidence, observation, and light source, to the photometric brightness of a perfectly reflecting or transmitting, perfectly diffusing surface or medium under the same conditions.

Reflectance or transmittance cannot exceed unity, but brightness (luminance) factor may have any value from zero to values approaching infinity.

Section 50. Aeronautic Lighting

The definitions in this Section have been prepared by the Committee on Aviation Lighting of the Illuminating Engineering Society.

50.005. Aeronautical Light: An aeronautical light is any luminous sign or signal, recognized by competent authority, which is established, maintained, exhibited or operated as an aid to air navigation.

50.005.1. Aircraft Aeronautical Light: An aircraft aeronautical light is any aeronautical light specially provided on an aircraft.

50.005.2. Aeronautical Ground Light: An aeronautical ground light is any light specially provided as an aid to air navigation, other than a light displayed on an aircraft.

50.010. Aeronautical Beacon: An aeronautical beacon is an aeronautical ground light visible at all azimuths, either continuously or intermittently, to designate a particular point on the surface of the earth.

50.011. Aerodrome Beacon: An aerodrome beacon is an aeronautical beacon used to indicate the location of an aerodrome. (An aerodrome is a defined area on land or water—including any buildings, installations, and equipment — intended to be used either wholly or in part for the arrival, departure and movement of aircraft.)

50.011.1. Airfield Beacon: An airfield beacon is an aerodrome beacon used at an airfield. (An airfield is any aerodrome other than an airport.)

50.011.2. Airport Beacon: An airport beacon is an aerodrome beacon used at an airport. (An airport is an aerodrome in which the facilities have, in the opinion of the competent authorities, been sufficiently developed to be of importance to civil aviation.)

50.012. Airway Beacon: An airway beacon is an aeronautical beacon serving to indicate a point on the airway.

50.013. Hazard Beacon: A hazard beacon is an aeronautical beacon used to designate a danger to air navigation.

50.014. Identification Beacon: An identification beacon is an aeronautical beacon emitting a coded signal by

means of which a particular point of reference can be identified.

50.015. LANDMARK BEACON: A landmark beacon is an aeronautical beacon used to indicate the location of a landmark used by pilots as an aid to en route navigation.

50.016. COURSE LIGHT: A course light is an aeronautical ground light, supplementing an airway beacon, used to indicate the direction of the airway and to identify by a coded signal the location of the airway beacon with which it is associated.

50.020. ANGLE-OF-APPROACH LIGHTS: Angle-of-approach lights are aeronautical ground lights arranged so as to indicate a desired angle of descent during an approach to an aerodrome.

50.025. APPROACH LIGHTS: Approach lights are a configuration of aeronautical ground lights located in extension of a runway or channel to provide visual approach and landing guidance to pilots.

50.026. LEAD-IN LIGHTS: Lead-in lights are a line of aeronautical ground lights located in extension of the runway or channel centerline to provide alignment guidance to pilots during approach for landing.

50.030. OBSTRUCTION LIGHTS: Obstruction lights are aeronautical ground lights provided to indicate obstructions.

50.035. BOUNDARY LIGHTS: Boundary lights are aeronautical ground lights delimiting the boundary of a landing area.

50.040. RANGE LIGHTS: Range lights are groups of color-coded boundary lights provided to indicate the direction and limits of a preferred landing path normally on an airport without runways but exceptionally on an airport with runways.

50.041. RUNWAY LIGHTS: Runway lights are aeronautical ground lights arranged along a runway indicating its direction or boundaries.

50.042. THRESHOLD LIGHTS: Threshold lights are aeronautical ground lights so placed as to indicate the longitudinal limits of that portion of a runway, channel or landing path usable for landing.

50.045. STOPWAY LIGHTS: Stopway lights are aeronautical ground lights arranged along the sides of an area provided in extension of a runway for deceleration and stop of aircraft after an interrupted take-off.

50.046. OVERRUN LIGHTS: Overrun lights are aeronautical ground lights arranged along the sides of an area provided in extension of a runway or stopway for safety of aircraft touching ground prior to arriving at the approach end of the runway or rolling beyond the end of the runway or stopway. Overrun lights are normally a portion of an approach or lead-in lighting system.

50.050. CHANNEL LIGHTS: Channel lights are aeronautical ground lights arranged along the sides of a channel.

50.055. TAXI-CHANNEL LIGHTS: Taxi-channel lights are aeronautical ground lights arranged along a taxi-channel to indicate the route to be followed by taxiing aircraft.

50.060. TAXIWAY LIGHTS: Taxiway lights are aeronautical ground lights arranged along a taxiway to indicate the route to be followed by taxiing aircraft.

50.065. SIGNALLING LAMP: A signalling lamp is a device used for directing light signals at individual targets.

50.066. PORTABLE TRAFFIC CONTROL LIGHT: A portable traffic control light is a signalling lamp producing a controllable distinctive signal for purposes of directing aircraft operations in the vicinity of an aerodrome.

50.070. CEILING PROJECTOR: A ceiling projector is a device designed to produce a well-defined illuminated spot on the lower portion of a cloud for the purpose of providing a reference mark for the determination of the height of that part of the cloud.

50.080. NAVIGATION LIGHTS: Navigation lights are a set of aeronautical lights provided to indicate the position and direction of motion of an aircraft to pilots of other aircraft or to ground observers. (Also called Position Lights.)

50.085. AUXILIARY POSITION LIGHT: An auxiliary position light is an aircraft aeronautical light used to supplement normal navigation lights in the forward direction. (Also called Passing Light.)

50.090. ANTI-COLLISION LIGHT: An anti-collision light is a flashing aircraft aeronautical light designed to produce a high-intensity red signal for the purpose of giving long-range indication of aircraft location to pilots on possible collision courses.

50.095. FUSELAGE LIGHTS: Fuselage lights are aircraft aeronautical lights, mounted on the top and bottom of the fuselage, used to supplement the navigation lights.

50.100. FORMATION LIGHT: A formation light is a navigation light of modified characteristics, used to facilitate formation flying.

50.105. WING CLEARANCE LIGHTS: Wing clearance lights are a pair of aircraft lights provided at the wing tips to indicate the extent of the wing span when the navigation lights are located an appreciable distance inboard of the wing tips.

50.110. ANCHOR LIGHT: An anchor light is an aircraft light designed for use on a seaplane or amphibian to indicate its position when at anchor or moored.

50.115. LANDING LIGHT: A landing light is an aircraft aeronautical light designed to illuminate a ground area from the aircraft.

50.120. TAXI LIGHT: A taxi light is an aircraft aeronautical light designed to provide necessary illumination for taxiing.

50.125. ENGINE CHECK LIGHT: An engine check light is an inspection light designed to illuminate the engine nacelles of an aircraft.

50.130. ICE DETECTION LIGHT: An ice detection light is an inspection light designed to illuminate the leading edge of the wing to check for ice formation.

50.140. PARACHUTE FLARE: A parachute flare is a pyrotechnic flare attached to a parachute and designed to illuminate an area of the ground from an altitude.

Address Changes should be reported to I.E.S. Headquarters by the first of any month, to insure the uninterrupted mailing of I.E. and other Society communications.

Views and Opinions

Futures Unlimited

WHO WILL see, and *what* will they see — tomorrow? Today, some fraction of 169,500,000 persons in these United States may logically ask that question, speculating upon the fact that 80 per cent of today's illuminants were unknown some 20 years ago, or that the electrical procedures of the next ten years may set the course of civilization for centuries—whether towards astounding achievements, or towards destruction!

Lighting, if we neglect for the moment all other factors, will naturally grow with increased number of users. The U. S. population in 1900 was 77 million; in 1910, 93 million; predicted for 1967, more than 181 million. On January 28, 1954, the electric meter was connected for the 50,000,000th customer!

Potentially, there are 1.5 million new lighting customers (users) each year. That's roughly 29,000 each week; 172 every hour!

World-wide, this globe supported two billion people in 1900. Predicted in 2030, about four billion, and by 2230, maybe sixteen billion — when we will severely need new sources of power and may desperately grow our food under artificial radiation. In that teeming civilization, we will dare not waste one acre, one drop of water, one erg, one lumen!

That additional 12 million persons, conservatively comparing today's U. S. population with 1967, at the present annual (and growing) rate of using 6.5 general lighting service lamp bulbs per capita, may consume some 78 million *more* lamps each year, a decade hence. Predicted for 1960, the general large lighting lamps, including fluorescent and mercury, may reach the astounding total of over 1,260,000,000 units!

And the *power* to burn them all? Little over a year ago, we (in 1955) had an installed 114,000,000 kilowatts of capacity; by 1965 the total is timidly estimated at 231,000,000 kw, perhaps as much as 250,000,000.

Since it is already programmed to have more than 10 per cent of this in nuclear fission (atomic) power, no one fears the inevitable shrinkage of fossil fuels as vital to lighting. To burn all of today's lighting lamps in this country, requires at least 185 billion kwh annually (out of over 600 billion sold), but this is miniscule contrasted to the sun's *daily* output of one thousand trillion kwh.

Naturally, then, some of the far-seeing engineers concern themselves with the capture of up to 22 per cent of this impinging solar energy, using at present the silicon crystal cells to convert incident "sunlight" (at approximately 5000 to 10,000 Å wavelength) directly to electricity, at about 100 watts per square yard. Each "razor-blade" cell develops nearly half a volt, when incident footcandle levels are above 2000. The output under continuous loadings now averages some 40 mw per sq. in.; or with 10,000 footcandles, the short-circuit current reaches 200 microamps per sq. in. of cell.

Thus, greater power for greater light seems assured. The ultimate fulfillment seems to depend on ingenuity, and sees no impenetrable barriers — no dim views!

Backed by an assurance of power and of illuminants, what footcandle values may we expect to find comfortable — yes, physiologically and economically necessary? Gently, almost timidly, we sought in the State Codes to encourage (as for medium average industrial tasks) no less than 0.5 to 1.0 footcandle, in 1910. More rational, but not more expensive, footcandles, of 10 to 20 were advised for the similar tasks, in 1955. Surely by 1967, the good practice standards (still at no greater unit cost) will advance to at least 50 to 100 footcandles!

Realistic wiring and sensible distribution planning should aim at no less than 5 watts per square foot of floor area in work, sales, or major living spaces. The 30 footcandles that now seem "horse and buggy" standards for our school children's eyes, in classrooms, really equal just one-third of one per cent of the daylight that children enjoy on the outdoor playground!

When man's lighting is good—or made better—it is generally used longer. Based upon recent observations, it is conservative to state that by a decade hence, the burning-hours of illuminants will be 10 per cent more, or increased by the factor of 1.1 in the formula.

So we may write a *Lumen-Hour Formula*, for "tomorrow," scarcely ten years away:—

Lumen-Hours = 1.2 (population increase) × 3.0

(footcandle growth) × 1.1 (longer usage) = 3.96, or let's say a multiplier of 4. Four times the amount of light used today, in 1967!

All of us see four basic ways of generating this future radiant energy.

1. Incandescence, by resistance, or by high frequency induction heating, of semi-conducting metallic or refractory materials, where efficiency, life, and color are largely the functions of temperature.

2. Fluorescence, by short-wave excitation of resonant phosphors, wherein the color resides in the chemical composition of the inorganic phosphor, or, in unusual cases, in the frequency, and where life is usually a matter of electrode disintegration.

3. Metallic vapors, or excited gases, that tend to have color as an inherent characteristic of the vapor, but where color may be modified by fluorescent bulb coatings, filters, or by arc temperature. Here the chief desideratum is long life at fairly high efficiencies.

4. Electroluminescence, or the condenser "sandwich," operating by direct excitation of special phosphor films coated on translucent plates, and where color is notably influenced by frequency, and efficiency by both frequency and voltage.

1a. The promises for incandescent filament lamps are limited, but by no means negligible! These sources will certainly grow prettier in color and shape. The future of larger wattage sizes with coiled-coil filaments, and perchance more viscous gases, promises some 10 per cent increase in sustained lumens per watt.
Also, one sees, as in examples of tungsten carbides heated by radio-frequency (wireless) power, those super-brilliant, concentrated sources operating on such as 4 megacycles, at 1.0 ampere, 4000 volts.

2a. Tomorrow's fluorescent tubular lamps seem certain to grow in loading, from 10 to 30 or more watts per foot. By using optimum pressures of gases, changed tube cross sections (or arc constrictions), and slowly improving phosphors, we may expect decidedly brighter lamps.
High voltages (say 600 v) and high frequencies (say 400 cycles), suggest supplanting large, heavy ballasts by baby-size capacitors, achieving not so much efficiency betterments but consequential lessening of ballast losses, and a reduction of heat losses. Obviously, the fluorescent story has not become a closed book.

3a. The vapor illuminants have far more promise for improved economy and for variety of color than when introduced 30 years ago. Far-seeing engineers believe that while mercury vapor will continue to be basic, yet other metals may be added for special services — Caesium for infrared radiation; Tellurium for its golden white color; Zirconium for spot sources, etc. At some 275 volts, the ballasting gear for 400- to 1500-watt range mercury lamps is surprisingly economical.
For the forthcoming decade, one sees several varieties of color-improving phosphors, plus color filters for adapting mercury lamps to commercial and industrial interiors. The expected (and achieved) service life of some 20,000 hours adds favorable argument to this concentrated arc source, whose light can be best shielded and redirected to specific targets.

4a. The electroluminescent plate or cell is a source of peculiar promise. Any future appraisal will include the factors of controlled brightness (some such range as 0 to 50 foot-lamberts); the possibility of controlling tint of color by the changes of frequency, and the question of ultimate voltage standards.
One school of thought urges standardization of 400 cycles, 600 volts, at once, lest we drift into a maze of complicating varieties of service conditions and standards. However, going from, say 500 cycles to 1500 cycles, just about doubles the brightness of a typical electroluminescent plate, while a similar gain occurs when changing from 300 to 600 volts, so tomorrow's commercial units may well be expected to deviate considerably from today's specimens. Today's installed price of over $25 per square foot is discouraging, but the ideas of exceedingly long life, low heat, and negligible space, do attract the dreamer who sees promise in direct conversion of electric power to luminous radiation, at a theoretical operating efficiency of at least four times that of today's mercury or fluorescent lamps. But today, we fall far short of that figure, and may for an indefinite future.

Each new advance towards the expanding horizons of radiation seems to be a recurring stimulant to man's imagination. Each step to a higher plateau of light enlarges the vistas of unlimited futures. — DR. SAMUEL G. HIBBEN, *Holophane Company, Inc., New York, N. Y. Digest of an address before the Northeastern Regional Conference, I.E.S., June 14, 1957.*

LIGHTING NEWS

1957 National Technical Conference

Apparently it's *true* what they say about Dixie. Atlanta was billed as a delightful place to hold a meeting. It is. The program for this conference, from technical sessions to parties, was said to be one of the best ever planned for an I.E.S. convention. Nine hundred and twenty-six members of I.E.S. can corroborate that this is so. It might be said, however, and with some truth, that given this particular group of committee men and women, the conference would be a memorable one almost anywhere.

Members of I.E.S. who were unable to attend the Atlanta Conference may still read both Presidents' addresses in the September issue, abstracts of the papers also; and the General Secretary's Report in next month's issue of I.E. Delegates who were present, however, have the advantage. The Officers' Report, traditionally the first order of business at all I.E.S. National Conferences, gives meaning to the whole year's operation. As General Secretary Richard G. Slauer so aptly put it, this report to the members provides a view of the tree and even perhaps of the acorn, of the great forest of I.E.S. activity.

One advantage impossible in the printed word, for example, was a first-hand report from chairmen of several important Society programs, as part of the General Secretary's Report to the members. Separate reports from the floor were given for the Membership Committee, by Brooks Chassaing; for the Lighting Service Committee, by Lee Tayler; and for the Allied Arts Committee, by Karl Staley. Numerous other phases of the Society's past year were outlined by Mr. Slauer, and as mentioned, will be further presented in his published report in December I.E.

Similarly, the printed word, valuable as it may be for the record, cannot convey the warmth of the personal message of President Waterman, and incoming President Reid, the former reporting on his completed administration, the latter on the Society's aims for 1957-1958.

Statistics

Attendance:	
Delegates	663
Ladies	263
Total	926
Place:	Atlanta Biltmore Hotel Atlanta, Georgia
Time:	September 9-13, 1957
Presiding:	Joe B. Browder, Chmn., Conference Executive Committee
Attendance Award Winner:	Cleveland Section

Forty-eighth National Technical Conference of I.E.S. (two war years missing) is opened September 9, Biltmore Hotel, Atlanta, Georgia. Presiding is Chairman of the National Technical Conference Committee, James C. Forbes. At left, General Secretary R. G. Slauer; at right, Kirk Reid, incoming President.

A feature of the General Secretary's Report to the Membership was individual reports by chairmen of specific activities. Here Brooks Chassaing, Membership Chairman, reports from the floor; General Secretary Richard G. Slauer is behind the podium, and incoming President Kirk M. Reid seated at the table.

Mint Juleps, soft Southern evening, gay summer dresses. No one there will ever forget the Reception in honor of President and Mrs. Waterman, held on the lovely outdoor terrace of the Biltmore Hotel, Atlanta.

Medallist — Prof. John O. Kraehenbuehl, right, receives the Society's highest honor, the Gold Medal Award, and Certificates for "meritorious achievement which has conspicuously furthered the profession. . . ." President Waterman, left, made the presentation. Looking on are l. to r., John E. Sweatte, past-chairman of the Georgia Section, and William M. Pearson, current chairman.

Gold Medal

A high spot of the Opening Session at Atlanta was the presentation to Professor John O. Kraehenbuehl of the I.E.S. Gold Medal and Certificate, and Professor Kraehenbuehl's acceptance address. For the record, this is published elsewhere in this Section. This year's Medal was awarded in recognition of his far-reaching effect on the techniques of illumination in his long teaching career. Some twenty of the Professor's former students were present to see him receive this highest honor in illumination. All of these men are themselves high in the profession of illuminating engineering, and several are Fellows of I.E.S.

MMILJ Competition

This year's contest for "My Most Interesting Lighting Job" marked its sixth year as a national competition, and its largest to date. Its popularity now brooks no opposition, and even technical sessions were suspended Wednesday morning, September 11, when the contest was the featured program. For the first time, parallel sessions were required. Class I, Residential, and Class II, Commercial,

Residential Lighting Division of MMILJ contest. Left to right: Ed Schnoll, Midwestern Region; Robert Babcock, proxy for Sylvan Shemitz, Northeastern Region; George Matilo, Great Lakes Region; Edna Fortier, South Central; Jack Cottingham, Pacific Northwest; John Felton, proxy for Ruth Patterson, Southwestern Region; and Jack Murrah, Southeastern Region. Missing from the photograph are Gerald Joseph, Inter-Mountain Region and Al Schramm, South Pacific Coast Region.

MMILJ Contest, Commercial Lighting Division had ten national entries, seven of them shown here. Fingers crossed following the contest are: R. J. Uhl, Inter-Mountain Region; H. F. Poehling, Midwestern; H. S. Gregory, South Central; E. D. Stevens, Southeastern; Harold Strahn, South Pacific Coast; Earl Dinsmore, Southwestern; R. W. Benjamin, Northeastern Region. Three missing from the picture: G. Denis, Canadian Region; W. F. Rosacker, East Central, and L. T. Genise, Great Lakes.

sections of the contest were presented in separate auditoriums simultaneously. As mentioned elsewhere in this issue, the contest nationwide had 203 entries, of which 18 Regional winners traveled to Atlanta to compete for first prize in the separate classifications. The winners:

Class I — Residential

FIRST — Mrs. Edna Fortier, New Orleans Section, South Central Region — Penthouse in the Clouds.

SECOND — George E. Matilo, Cleveland Section, Great Lakes Region — Re-Modeling a Home.

THIRD — Jack T. Cottingham, Oregon Section, Pacific Northwest Region — Electri-Living Home.

FOURTH — Edwin Schnoll, Milwaukee Section, Midwestern Region — A Fox Point Residence.

Runners-up in Class I, National Contest, were: Sylvan Shemitz, Connecticut Section, Northeastern Region; and Jack Murrah, Georgia Section, Southeastern Region. D. R. Webb, Maritime Chapter, Canadian Region; Gerald Joseph, New Mexico Chapter, Inter-Mountain Region; and Al Schramm, San Diego Section, South Pacific Coast Region, were not in Atlanta to present their entries.

Class II — Commercial and Industrial

FIRST — H. J. Poehling, St. Louis Section, Midwestern Region — St. Louis Air Terminal Building.

SECOND — Lawrence T. Genise, Michigan Section, Great Lakes Region — University of Michigan Exhibition Swimming Pool.

THIRD — Earl I. Dinsmore, North Texas Section, Southwestern Region — Vick's Restaurant.

FOURTH — W. F. Rosacker, Eastern Pennsylvania Section, East Central Region — A Challenge in Church Lighting.

Runners-up in Class II in the Atlanta judging were: Robert J. Uhl, New Mexico Chapter, Inter-Mountain Region; J. F. Barney and Russell Benjamin, Connecticut Section, Northeastern Region; Harold Strahn, Southern California Section, South Pacific Coast Region; G. Denis, Montreal Section, Canadian Region; H. S. Gregory, New Orleans Section, South Central Region; and E. D. Stevens, Tar Heel Section, Southeastern Region. B. T. Heinz, Puget Sound Section, Pacific Northwest Region was not present to show his entry in the National contest.

Judges in the Class I division were L. Ralph Bush, E. W. Commery and Myrtle Fahsbender. Class II was judged by C. L. Crouch, James M. Ketch and T. C. Sargent.

PROGRESS REPORT

"Around the World in Eighty Minutes" said the advance billing for this popular Conference feature. This was no idle boast. J. H. McCulloch m.c.'d this production, dressed (with further apologies to Michael Todd) in the colorful costume of Phineas Fogg and with background music from the movie of similar title. For a great many people attending the Conference, the Progress Report alone is worth the trip. Almost no one misses this program; the largest auditorium the Convention hotel has to offer is invariably packed; convention goers soon learn to come very early or stand throughout the performance. Dedicated delegates may attend only to hear (and see) what's new in lighting. In this they are not disappointed. Over 75 different items, all representing new developments in equipment, technique, and sources, were displayed. With a Progress chairman as gifted as Mr. McCulloch, it's no surprise that their presentation is dramatic and entertaining as well as educational. Whirling off on his 80 minutes, Chairman McCulloch sped down the center aisle of the auditorium on a motorcycle, Phineas' swallow-tails flying. The program which followed was just as brisk, just as entertaining. Also highly informative. Its text is scheduled for publication in the January issue of I.E.

Assisting Mr. McCulloch in this wonderful performance were E. A. (Red) Linsday, vice-chairman of the Progress Committee, and 19 hard-working committee men who toiled throughout the day and all through the performance.

AWARDS

On various occasions during the Conference, nine important awards were made. The top award is, of course, the Gold Medal, already mentioned. In addition:

White lapel pins denoting Fellow grade in I.E.S. were presented during a ceremony at the opening session, to ten newly elected Fellows. All were on hand to receive this honor. President Marshall Waterman made the presentation to:

Membership Campaign awards were presented by Brooks Chassaing during his report for the General Secretary. Accepting checks for the winning Sections: (Photo above left) R. Neal Campbell, Palmetto Section; Bill Beazley, Montreal Section; Mr. Chassaing, and President Marshall Waterman. (Photo above) Dana Rowten, Cleveland Section; Walter Fink, Georgia Section, and Mr. Campbell and Mr. Chassaing again. (Photo at left) J. D. Mitchell, Southeastern Regional Vice-President accepts the certificate for his Region, winner of the Regional Membership high gains and low losses contest.

George A. Freeman, J. S. Hamel, Charles W. Jerome, J. Roy Jones, William W. Lozier, James H. McCulloch, Alston Rodgers, Dana W. Rowten, Theodore H. Shepherd, Ray P. Teele.

Membership Campaign winners received prize money for their winning Sections and Chapters from Brooks Chassaing during his report on membership, a feature of the General Secretary's Report at the opening session. This award went to: Pacific Northwest Region as winner in "Gains" in the membership competition; Southeastern Region for "Low-Losses."

Group I — for top gains, Michigan Section. For low-losses, Cleveland Section.

Group II — top gains, Montreal. Low-losses, Georgia Section.

Group III — top gains, Palmetto. Low-losses, also Palmetto.

Group IV — top gains, Edmonton Chapter. Low-losses, Mexico Chapter.

Checks for $25.00 for each of these were presented to representatives of the winning Region, Section or Chapter, before an assembled (and applauding) membership.

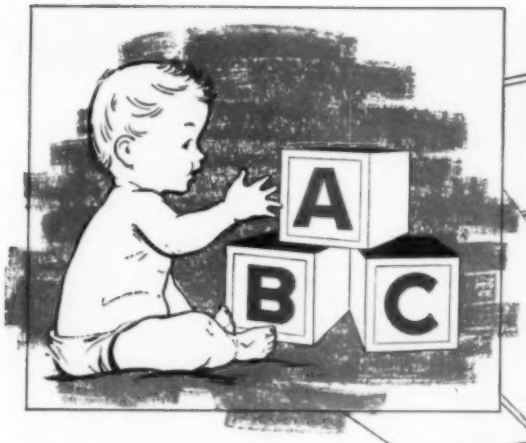
Three Charter presentations were made by President Waterman during the Conference. One new Chapter received its Charter. This was the new group known as the Coastal Empire Chapter of I.E.S., with headquarters in Savannah, Georgia, serving the area from Charleston to Brunswick. The Charter was received by Dallas McClellan, Chairman of the Chapter.

Two Chapters, advanced to Section status, received their new Charters. These were Southeast Florida Section, accepted by J. V. Shellhorse, and Palmetto Section, the Charter being received by Neal Campbell. Both were Chairmen of their respective Sections.

The "Travel Gavel" this year went to the Cleveland Section, and was accepted by the incoming Chairman Robert W. Morris. Presentation of the gavel and its accompanying anvil was made by President Waterman during ceremonies at the Banquet. With 71 members present, Cleveland won this annual contest for the most members present in relation to total Section membership, and miles traveled to the Conference. In second place, New

(*Continued on page* 12A)

Residence Lighting Forum Session presented, s.r.o., three major papers on new home lighting techniques by, l. to r., Dr. Domina Eberle Spencer, Mary Taepke and E. W. Commery.



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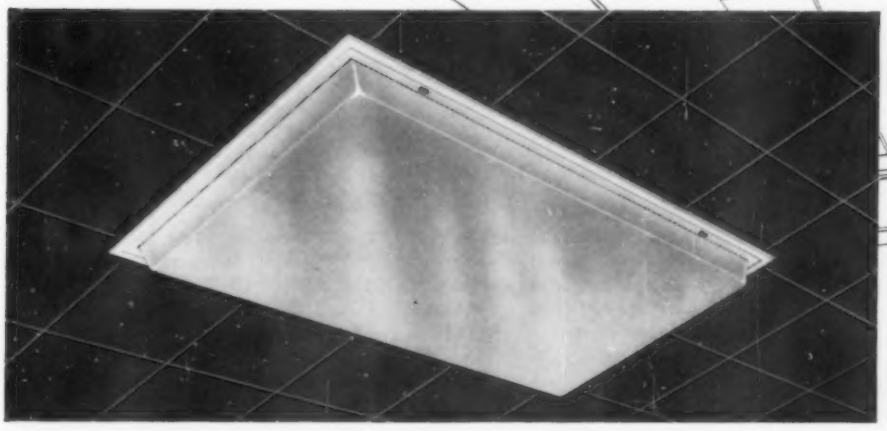

3 BASIC MODULAR TYPES

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Three Charters were presented by President Waterman during ceremonies Sunday evening, September 8. Shown is J. V. Shellhorse accepting the Section Charter for Southeast Florida group. Other Charters presented were to the new Coastal Empire Chapter, and to the Palmetto Section, accepted by Chairmen, D. L. McClellan, Jr., and R. Neal Campbell.

Come to Toronto. The literature piling the table of the Canadian booth, at the Atlanta Conference, tells only a fraction of the wonderful advantages of a Conference in Toronto. Manning the display, next year's hosts, l. to r., Joe Bateman, 1958 Conference Chairman, J. Carl Wilson, Canadian Regional V-P., and Bob Lindsay, all of the Toronto Section of I.E.S.

(Continued from page 10A)

Orleans with 20 members present; in third place, New England Section with 33 members on hand. The anvil which accompanies the traditional gavel award was the gift of the British Columbia Section, winner of the award in 1948. A number of the Sections and Chapters of the Society have been especially successful in capturing the gavel. Those groups which have won it a substantial number of times are: New York, seven times; Cleveland, eleven times; New Orleans, winner at the last six Conferences, has won seven times.

A new Gavel Award made its appearance for the first time this year — the "Ketch Gavel" to the retiring President. This was the gift of James M. Ketch, a Fellow of I.E.S., a Past-Director and Past-Treasurer, who retired, on September 30, after 40 years with the General Electric Co., Nela Park. The gavel, beautifully turned and finished, was handmade by Mr. Ketch, using American Beech wood. Its design is an exact replica of the official gavel of the United States Supreme Court. It carries a silver plate inscribed "M. N. Waterman, I.E.S. President, 1956-1957." The gavel was presented to Mr. Waterman during the Past-President's luncheon on Monday afternoon.

Judging in the Allied Arts Contest. The jury, left to right: Jack H. Murrah, electrical engineer; John Portman, architect; Joe Armisano, architect; Charles Howe, electrial engineer; Matt Jorgensen, architect (seated); L. Ralph Bush, electrical engineer (seated). Right, Karl Staley, Chairman, Allied Arts Committee.

Allied Arts Awards, for the nationwide architectural contests conducted under the chairmanship of Karl A. Staley, were made September 10. Two students at the Georgia School of Technology won first honors in this Allied Arts contest. John Reece, an architectural student, and William Y. McCachern, an electrical engineering student at Georgia Tech, led in the final balloting with a restaurant design. Their sketches and specifications, conceived cooperatively, were submitted by Professor Howard McKinley of the Electrical Engineering School, a member of the Georgia Section of I.E.S. Second and third places in this annual contest were awarded, respectively, to Alan Gallion, an architectural student at the University of Southern California, Los Angeles, and Miss Cordette McCracken, an interior decorating student at Pratt Insti-

(Continued on page 15A)

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Featuring built-in versatility of size, closure, and lighting level, Miller Versaline-Grid Recessed Troffers are especially designed for exposed "T" furring and Acousti-Line ceilings. Ideal for lighting stores, offices, schools and public buildings.

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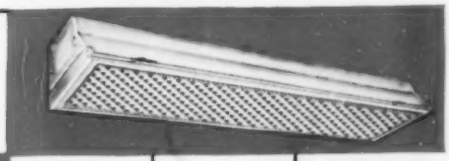

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Monotube Lighting Poles

(*Continued from page* 12A)

tute, Brooklyn, N. Y. Jerry Rembowski, an architectural student, and Rex Lanning, an art student, both at Kent State University, Kent, Ohio, won honorable mention. Serving on the panel of judges were: Joe Amisana, architect; L. Ralph Bush, consulting engineer; Charles F. Howe, consultant; Matt Jorgensen, architect; Jack Murrah, engineer; and John Portman, architect and designer.

To honor the first President of I.E.S., L. B. Marks, who held office in the Society's first year, 1906, a diamond-studded Past-President's pin was presented to Mrs. Marks during Banquet ceremonies. In her absence, the pin was accepted and acknowledged with appropriate remarks by Dr. Ward Harrison.

A final award — the Certificate of Appreciation for service as President, 1956-1957, signed by all members of the 1956-1957 Council. This was presented to outgoing President Waterman, along with the Past-President's pin, by incoming President Kirk M. Reid. In the same ceremony, during the Banquet on Thursday evening, Mr. Reid received the gavel, as the new President of I.E.S.

On behalf of Mrs. L. B. Marks, widow of the Society's first President, Dr. Ward Harrison, right, accepts for her the Past-President's Pin. The presentation was made by President Waterman during the banquet ceremonies.

Trips and Tours

During the 1955 Convention in Cleveland, the Conference planners felt considerable trepidation for their plan to transport the entire convention seven miles to Nela Park for a fish fry and outdoor entertainment. In Boston last year, no hitches developed in going twenty miles to Plymouth for a Clam Bake. So with no qualms whatsoever, and quite rightly, the Georgia Section hosts moved the group, 1000 strong, eighty miles on Wednesday afternoon, for an outdoor barbecue, Southern style. Furthermore, they touristed on the way, stopping the buses for a trip through the Little White House, F.D.R.'s home in Warm Springs.

Destination for the cavalcade of buses was the Ida Cason Callaway Gardens in Chipley, Georgia, 80 miles from Atlanta. Purpose was an afternoon of tremendous fun. The I.E.S.ers fanned out over these beautiful gardens, losing no time in sampling the many wonderful things to do, to each his own. Experts and novices alike tried aquaplaning on the lake. Hundreds of others made a bee-line for the cool waters of the lake for a swim. Cleopatra's Barge toured the lovely lakes with others, and the stout of heart took to the speed boat rides. The miniature railway did a big business, and so did the sight-seeing buses which toured the entire, beautifully planted, area. By dusk no bell was needed to summon the multitude to supper.

Northerners and westerners added to their ken the delightful experience of Brunswick Stew, barbecued pork and other Southern picnic specialties. When it is considered that many hours are required for their preparation and that close to a thousand hungry revelers were fed piping hot food promptly, the prowess of the Georgia committees can begin to be appreciated. The entire project was an enormous success. Busloads of happy picnickers filled the country night with song on the two-hour ride back to Atlanta.

Ladies Program

For the 263 wives who accompanied the members to Atlanta, the barbecue was only one of the trips, albeit a good one. They had a trip of their own the first

(*Continued on page* 16A)

Incoming — Outgoing. An impressive ceremony during the banquet is the installation of the new President. In the picture at left, President Waterman passes the gavel to the new I.E.S. President, Kirk M. Reid. At right, President Reid, now behind the podium, presents Mr. Waterman with a certificate of appreciation for his service, after pinning on his lapel, the diamond-studded pin denoting a Past President of the Society.

So proudly we hailed — head table at banquet and entire assemblage joined in singing "God Save the Queen," and "The Star Spangled Banner."

(*Continued from page* 15A)

day of the Conference. This was to Argyle House for tea. The trip was made in car pools, with Atlanta I.E.S. wives as hostesses, the drive taking the group first through Atlanta's beautiful north-side.

Monday was a very full day for the ladies, as a matter of fact. Breakfast was served on the Terrace (and on the Section) every day of the Conference, starting with a get-acquainted breakfast Monday morning. This was the starting point of many a happy trip and tour. Following the tea Monday, the ladies went to the Plantation Party (see Entertainment Program). And, of course, they also went to Callaway Gardens and the barbecue Wednesday. Tuesday's program included Bingo on the Terrace, for fun, prizes and cokes.

Before the Banquet Thursday, feminine visitors to the Conference had a choice of several trips and tours. Some went on the tour to Roswell (15 miles) to see charming ante-bellum homes, touring also the Art Association Museum on the way back. Another tour took others to see Greater Atlanta, including Stone Mountain and a stop at the Cyclorama, world famous painting of the Battle of Atlanta

ENTERTAINMENT PROGRAM

It's no news that Southerners have a gift for entertaining. Seventy-one of them concentrated on this phase alone for the Atlanta Conference. For the exceptional fun experienced, great credit is due to the group of 17 men and no less than 54 ladies who planned for weeks ahead of the meeting and all during the conference. We refer to the Entertainment Committee, Jack Burns, Chairman, and all of the 54 ladies who participated as co-chairmen of the Ladies Reception Committee.

First taste of the wonderful hospitality came even before the Conference started. An informal reception was held Sunday evening, September 8, where the pace was set for a whole week of gracious entertaining.

The Plantation Party Monday evening must have taken weeks to plan and execute — and from the viewpoint of those present it was worth every bit of the work involved. Site was the huge exhibition hall in the hotel, this transformed from its usual utilitarian appearance into a gay Plantation country dance. Hostesses all appeared in lovely ante-bellum growns, hoops gracefully swirling. Many of the Georgia members turned up as Southern gentlemen of the 1860's, top hats and swallow tails, and ever so gallant. And, entering into the spirit of things, all the men donned the Confederate caps which were handed out, before they took their places for the Virginia Reel. This party was a terrific success.

The Lighting Progress Report, already mentioned, could well be included as entertainment. This was the feature of Tuesday evening, September 10.

Wednesday's entertainment has also already been described. It was, of course, the enormously successful barbecue at Callaway Gardens. For this tremendous project, an accolade to the Entertainment Committee.

High spot of the social program, however, was the Banquet, Thursday evening, September 12. No one there will ever forget it. As with every other feature of the Conference, this affair was sparked with the intangibles of entertainment in the South, so difficult to record with words. To try: a balmy evening in Georgia, beautiful summer evening gowns, mint juleps in the terrace gardens outside, the white coats of the waiters, soft Dixie accents. This, for the Reception honoring President and Mrs. Waterman. A typical and gracious touch, the Hawaiian orchid corsages for every lady, a gift from their Georgia Section hosts.

For the Banquet itself, the exhibition hall had again been transformed, this time into a pillared Southern mansion. The international character of I.E.S. was apparent in the two flags — the stars and

(*Continued on page* 21A)

Joyfully received by President and Mrs. Waterman, a gift from the Georgia Section. Appropriately, this was a set of beautiful plates having original paintings of birds by the world-famous Georgia artist, Menaboni.

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LIGHTING PROGRESS

The fluorescent lighting industry has made tremendous progress in recent years. Advances in architectural styling, backed by new fixture designs and better application techniques, have brought to millions better light for modern living.

But progress almost always awakens new problems. So it is with lighting. For modern fluorescent installations, with all their style and efficiency, necessitate increasingly rigid control of ballast operating temperatures. Here's why:

New architectural designs incorporate lower ceilings, and sound-absorbing ceiling materials. Lighting fixtures are flush-mounted or recessed. There is also a growing demand for

DEMANDS BALLAST PROGRESS

higher working foot-candles. This means more lamps per fixture and higher lamp currents. To reduce possible glare caused by higher light output, fixtures now utilize louvers or lenses, which contribute to the retention of heat. And, because space is limited, smaller cross-section ballasts are used. Thus, modern fixtures ***generate more lamp and ballast heat, yet are less able to dissipate it.***

Because ballast life may be shortened if ballast temperatures are excessive, modern lighting design and application techniques place huge demands upon the ballast industry. If fluorescent lighting progress is to continue, better ballasts which will operate below standard industry heat specifications in modern applications must be developed. ***Thus, lighting progress demands ballast progress.***

In working toward ballast progress, General Electric engineers have recognized that high ballast operating temperature is perhaps the largest problem to be overcome. The most important single step in solving this problem has been the development of a realistic new approach and new facilities for accurately measuring ballast operating temperatures. In a specially-constructed, temperature controlled laboratory, ballasts are actually installed in modern, totally enclosed fixtures, without the aid of heat dissipating devices (except for normal ballast base contact with the fixture channel). These fixtures are flush-mounted or recessed against typical acoustical ceilings. Thermal measurements are taken only after the ballast has reached a stable operating temperature. ***Thus General Electric ballast heat measurements reflect actual, modern operating conditions.***

As a result of such research, General Electric's entire ballast line is continually undergoing major improvements designed to provide superior performance. The most recent example of G.E.'s research and development is the redesign of its 89G545 line of 40-watt, rapid-start ballasts to operate efficiently well below the industry standard of 90°C. in modern applications. Such ballast progress allows maximum latitude in fixture design and styling.

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New G-E testing laboratory simulates ballast operating conditions in modern fixtures, assuring realistic heat measurements.

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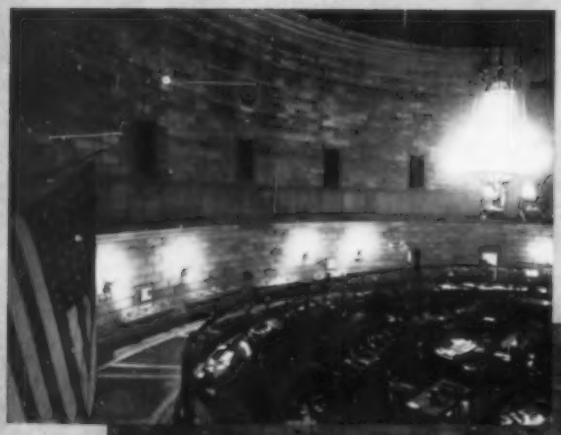

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(*Continued from page 16A*)

stripes and the union jack, which the assembly of some 1000 people faced in turn for the singing of both American and Canadian National Anthems. Foreign guests were introduced also, from Bermuda, Colombia, England and Japan.

Before the evening was given over to dancing, several interesting ceremonies were held. The lucky winners of the MMILJ contest were announced and received their checks and silver cups. The Past-Presidents and their wives were introduced; as is traditional they were seated at a special table directly in front of the speakers' table. Both gavel awards were presented, and some 200 local committee workers who had made the conference such a success were introduced and stood to receive their well-deserved applause.

It is at this point also that delegates witnessed a most impressive ceremony — the inauguration of the new President. The diamond-studded pin denoting Past-President was pinned to the lapel of President Waterman. He, in turn, presented the gavel of office to President Reid. Mr. Reid, in his "inaugural address" paid tribute on behalf of all the Society to President Marshall Waterman, and I.E.S. first lady, Serena Waterman. His address included an amusing "two-word summary" of Mr. and Mrs. Waterman, and of the past four Presidents of I.E.S. Given only two words to describe each of these people, his choice was: for Mr. Waterman — "eloquent statesman," for Mrs. Waterman — "charming, talented." For Everett Strong, president in 1952-1953, he suggested "farsighted educator"; for Homer Manwaring, "able executive"; Duncan Jones, "goodwill ambassador"; Bob Hartenstein, "dynamic salesman." President Reid's address was a warm and entertaining tribute to his predecessors, and a most fitting climax to the inaugural ceremony.

Past Presidents of I.E.S. present at a Conference, traditionally meet for luncheon. Present at Atlanta are: Walter Sturrock, Lee Tayler, Willard Brown, Herbert Magdsick, George Crampton, Kirk M. Reid, Ward Harrison, William F. Little, Al Wakefield, Charles Goddard, Everett Strong, Marshall Waterman, and R. F. Hartenstein.

Official and Unofficial Events

The record of this Conference would not be complete without some mention of a number of events not found in the printed program. The Past-President's luncheon, for example. This has become a tradition at I.E.S. National Conferences. At the Atlanta meeting, 12 of the 25 living Past-Presidents gathered for a private luncheon; messages from all the others were read. Past-Presidents attending this meeting were: Dr. George S. Crampton, Dr. Ward Harrison, H. H. Magdsick, W. F. Little, Willard C. Brown, A. F. Wakefield, Lee E. Tayler, C. H. Goddard, Walter Sturrock, E. M. Strong, R. F. Hartenstein, and the incumbent, Marshall N. Waterman. Incoming President Kirk M. Reid presided.

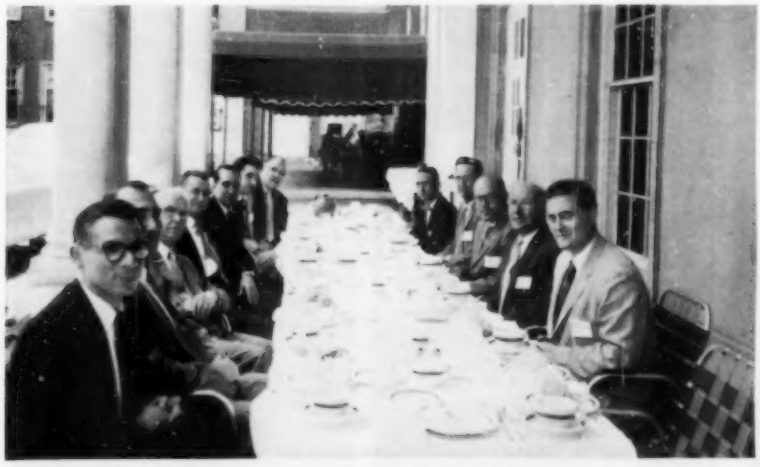
Another event which has become classic for I.E.S. Conferences, is the gathering of former students of Professor John O. Kraehenbuehl for a luncheon in his honor. This year's meeting included some twenty former students, who met for lunch with Professor Kraehenbuehl on the terrace of the beautiful Biltmore Gardens.

Not shown in detail on the conference program, is an event of considerable importance, held Sunday evening, September 8. This was the Regional contest for My Most Interesting Lighting Job, for both the South Central Region and the Southeastern Region. With no Regional Conference scheduled this year (because of the National Conference) these Regions held their contests just prior to the national meeting. Judges at the Southeastern Regional picked the following winners:

Class I (Residential) — First Prize, Jack H. Murrah, Georgia Power Co., Georgia Section.

Class II (Commercial and Industrial) — First Prize, Everett D. Stevens, Carolina Power & Light Co., Tar-Heel Section.

(*Continued on page 22A*)



Honoring their prof. John O. Kraehenbuehl, well-loved professor of Illumination formerly at the University of Illinois, was guest of honor at a luncheon with his former students. Site is the garden terrace of the Biltmore Hotel, Atlanta. Professor Kraehenbuehl is at right, second from front.

At the registration desk, l. to r.: A. D. Hinckley, Executive Secretary; Carroll Sweatman; Tom Pyron (on phone, background); Jim Callaham, and S. J. Andre.

Ticket sales for sports events and the banquet were handled by Jim Johnston and Walter McKinney. Customer, standing, is Wayne D. Baker.

Credit the success of this conference to these men and dozens like them, who worked for months ahead and put in ten-hour days during the week.

(Continued from page 21A)

In the South Central Region's contest, the following winners were announced:

Class I (Residential) — Mrs. Edna Fortier, Electrical Supply Co., New Orleans Section.

Class II (Commercial and Industrial) — H. S. Gregory, Gregory-Salisbury & Co., New Orleans Section.

These winning contestants the following Wednesday took part in the National contest, representing their Regions, with the results already noted.

"Official Events" at an I.E.S. Conference would have to include the golf tournaments, which were played on Wednesday afternoon, before the barbecue, at the Calloway Gardens Golf Course. Prizes competed for were:

Regar Cup. Five teams competed in match play with the Chicago Section team the winner.

Clarence Law Cup. This was won by Art Rowe, of the Chicago Section.

First Prize — for the second low medal score excluding handicap. Winner: Lou Goehring of the Georgia Section.

Second Prize — for best low medal score allowing handicap. Winner: H. F. Kingsbury of the Pittsburgh Section.

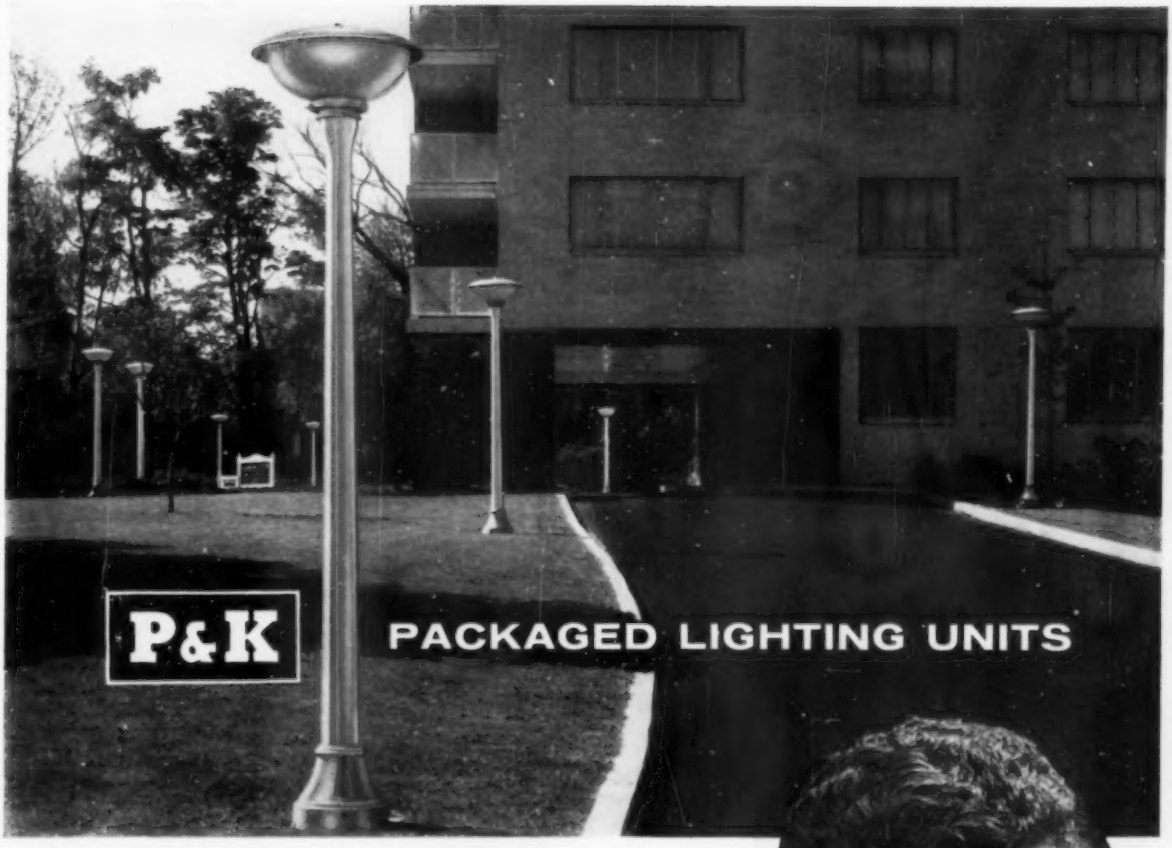
Third Prize — for second low medal score allowing handicap. Winner: C. J. Aas, Twin City Section.

Fourth Prize — for the drive nearest the hole on No. 9 green. Winner: Bob Kelly, Chicago Section.

Fifth Prize — for lowest score on No. 5 hole excluding handicap. Winner: Dana

(Continued on page 25A)

Two teams of capable projectionists contributed greatly to the smooth-running technical sessions, several in parallel. On the raised platform are Wesley Johnson and Jim Koen; at right Wray Buchanan at the projector, Jason Elrod operating lights. These men were members of the Audio-Visual Committee, Tom Haslam, chairman.



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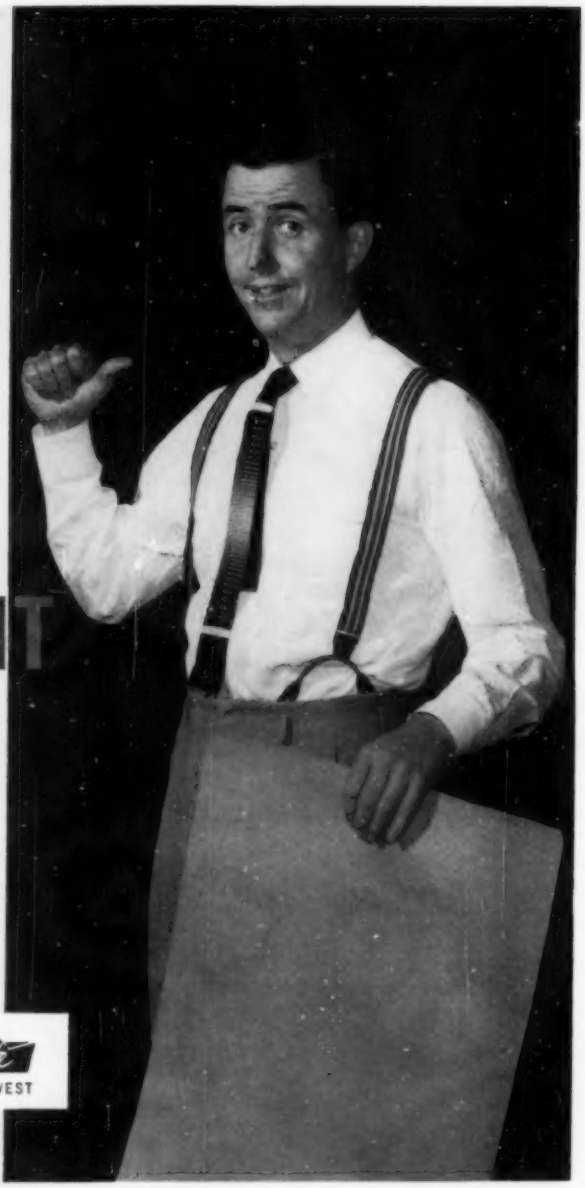

NOT ANY MORE! NEW ALL-BRITE PG FLUORESCENT DELIVERS MORE LIGHT AT LESS COST!

PG means fluorescent high-bay illumination, featuring **Power-Groove** lamps ... truly an industrial lighting milestone! Write for information.

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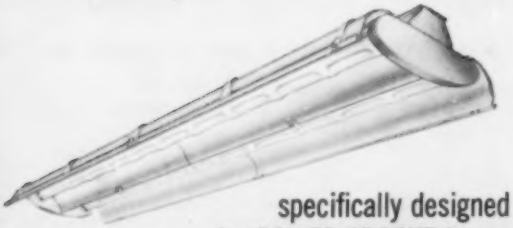
LIGHT OF THE WEST

CONVAIR INSTALLS 3000 PG ALL-BRITE

Lighting Plan by Convair San Diego Plant #2. Electrical contractor, Chula Vista Electric Company.



specifically designed for **POWER-GROOVE** lamps

FLUORESCENT FIXTURES OF CALIFORNIA

352 SHAW ROAD
SOUTH SAN FRANCISCO, CALIF.

PLANTS ALSO IN LOS ANGELES; PORTLAND, OREGON; AND VANCOUVER, B. C., CANADA

(*Continued from page 22A*)

Rowten, Cleveland Section.

First Booby Prize — for highest score on any one hole. Winner: Bob McKinley, Pittsburgh Section. Score: 12.

Second Booby Prize — for most golf balls lost during the afternoon. Winner: Marty Harkey, Florida Section. Number of balls lost: unspecified.

One notable "unscheduled event" was the marriage during the Conference of Kenneth Glass, a prominent member of the Street Lighting Committee. Mr. Glass and his bride then honeymooned at the I.E.S. convention.

Council meeting, too, though not listed on the program, was an important feature of the Conference. This was held all day Friday, September 13, and was attended by almost the full roster of Council members and numerous visitors as well.

PROGRAM

Pièce de résistance of any I.E.S. Conference is ever the technical program. This year's was exceptionally noteworthy in many of the papers collected and reviewed by the Papers Committee under the direction of Hedley F. Davidson, Chairman. Abstracts of all the papers were published in the September issue of I.E., and Transactions will be published in subsequent issues, together with discussion and rebuttal. For the record, a complete list of the program follows:

CONFERENCE PROGRAM

Monday Morning — September 9

PRELIMINARY SESSION — J. Dixon Mitchell, Vice-President, Southeastern Region, presiding.

Announcement of Regional Winners of MMILJ Contest, Southeastern and South Central Regions.

(*Continued on page 28A*)

Gold Medal Acceptance Address

By John O. Kraehenbuehl

Mr. President, Members of the Award Committee, the Council, Members of the Society and guests, it is with a very humble feeling that I stand before you as the recipient of the Illuminating Engineering Society Gold Medal Award. Since I have never held any office in the Society other than Local Representative, it can only be assumed that the Award is to my profession, as a symbol for all the teachers of Illumination who are my contemporaries.

I welcome this opportunity for disclosing what the Society, its organizations, committees and individuals have contributed to my development and pleasure in teaching. Contributions to a most enjoyable life and profession have been made by:

1. The Illuminating Engineering Society.
2. Lighting Institutes.
3. Chicago Section of I.E.S.
4. Lighting Industry.
5. Ilumination Students.

1. From I.E.S. — The ideas and the wisdom of the founders of this Society have made possible all that has been gained through association with I.E.S. Some of these include the opportunity to work with committees, the availability of its published information, and the stimulating experience of attending National Conferences. It has been a privilege to be associated with talented individuals and to have available published papers that have stimulated both effort and interest in the advancement of good illumination for the welfare of the individual. The contact with the many talents and professions has been a liberal education in itself. I have worked with, and have been inspired by, many of those who have previously been awarded the Gold Medal. Their contributions to the organization give me a yard-stick by which to measure my small stature and make the value of the Medal greater as an award to my profession.

It has been a pleasure to be associated with the Society during the period in which an accumulation of illumination knowledge has been developed into a Handbook, and a program initiated seeking new basic knowledge through the Research Institute. It would be a pleasure to live to see the Society develop a nomenclature not only for the Science of Illumination but for the Art of Illumination as well. There seems to be slow progress in this direction. We should also publicize our activities as a professional organization to lead to a more general acceptance of the Society as such.

2. Lighting Institutes — Two great Institutes have contributed much encouragement and many ideas for the presenting of Illumination material and principles, in the teaching of students. The Chicago Lighting Institute, because of nearness, was easily available and we were always welcomed on our yearly visit with classes. Here the students became acquainted with its work and with the methods of modern illumination design and practice. On occasions some of the students would, of their own free will during vacation periods, make the trip to Nela Park where they were always welcome at the Lighting Institute there, and from which place they always returned more enthusiastic and prepared to do better work in their courses.

3. Chicago Section of I.E.S. — In Chicago our students and the University staff had the fullest cooperation of the Chicago Section. Every effort was made to acquaint the students with the illumination field, and Branch meetings were sponsored by this organization, for which they would supply speakers, and made suggestions which enabled us to attract speakers from the industry. The Branch had every encouragement from its parent organization and this stimulation extended to the establishment of two scholarships which, though they did not defer all expenses, did encourage the recipients to greater efforts. These scholarship students are now finding recognized positions in the profession.

4. Lighting Industry — Contributions by industry were not a small part in the development of the students, courses, and teaching. The number who contributed equipment is so large that time would not permit their mention by name, but the University staff and I owe them much, not only for the equipment but for the information they were willing to let us have, often in confidence since it would be valuable to their competitors. We hope these confidences were never violated.

There is one industry award which contributes four scholarships per year to the Branch. These are known as the Holophane Scholarships and their stipends are an appreciable help toward the students' schooling. Of par-

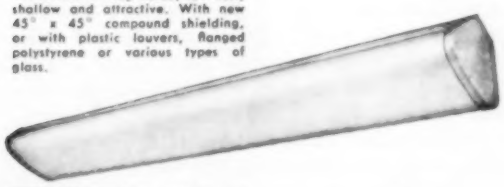
(*Continued on page 28A*)

the men from Smithcraft

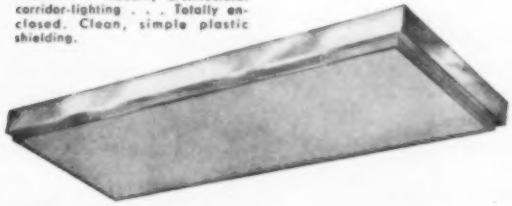
Charles Kleinschmidt and Harry Bailey, Louisiana representatives, members of Smithcraft's nation-wide sales-engineer organization, demonstrating the New Smithcraft TWOSOME.

Always ready to explain in detail the benefits of new lighting developments, the men from Smithcraft know the importance of teamwork in planning good lighting. When they team up with you and your associates to select a lighting fixture that fits both the budget and the blueprints, they can find the answer in Smithcraft's complete line of lighting units. Make it a point to consult with the Men from Smithcraft on any lighting planning.

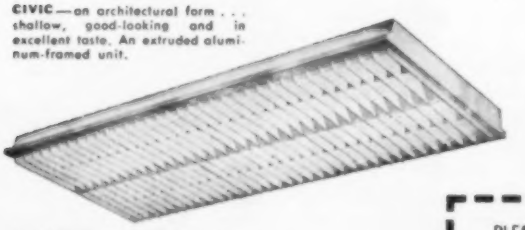
TWOSOME — Top value, low cost, shallow and attractive. With new 45° x 45° compound shielding, or with plastic louvers, flanged polystyrene or various types of glass.



FREEWAY — Modern, architectural corrider-lighting . . . Totally enclosed. Clean, simple plastic shielding.



CIVIC — an architectural form . . . shallow, good-looking and in excellent taste. An extruded aluminum-framed unit.



EXECUTIVE — an all-steel louvered unit; shallow with illuminated, tapered sides. Provides 30° x 45° shielding.

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Wherever good lighting is important, you'll find . . .

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LIGHTING
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☐ Please send me folders and catalog sheets on the "4 Good New Ideas in Lighting".

☐ Please send me the complete SMITHCRAFT CATALOG, containing data on America's Finest Fluorescent Equipment.

(*Continued from page* 25A)

OPENING SESSION — J. C. Forbes, Chairman, National Technical Conference Committee, presiding.

National Officers Report.
M. N. Waterman, President.
R. G. Slauer, General Secretary.
K. M. Reid, President-Elect.

Introduction of Fellows, 1957 — M. N. Waterman.

Presentation of I.E.S. Medal to Professor J. O. Kraehenbuehl.
Introduction by Berlon Cooper, Chairman, Medal Committee.
Presentation by President Waterman.
Response by Professor Kraehenbuehl.

Announcements — J. B. Browder, Chairman, Conference Executive Committee.

Monday Afternoon — September 9
(Parallel Sessions)

Applications I

Session Chairman — Floyd Sell, Detroit Edison Co., Detroit, Mich.
Discussion Organizer — W. V. C. Foulks, Curtis Lighting, Inc., Chicago, Ill.
Acoustics and Lighting — G. W. Clark, Sylvania Electric Products Inc., Wheeling, W. Va.
A Study of the Extraction of Heat from Fluorescent Luminaires in Air Cooled Rooms — Walter Sturrock, General Electric Co., Cleveland, Ohio, and L. F. Schutrum, American Society of Heating and Air Conditioning Engineers, Cleveland, Ohio.
Experience with High Level Office Lighting — J. M. Ketch and W. S. Fisher, General Electric Co., Cleveland, Ohio.
Footcandles, Footlamberts — What Next? — G. W. Clark and R. E. Harz, Sylvania Electric Products Inc., Wheeling, W. Va.

Photometry and Colorimetry

Session Chairman — S. K. Guth, General Electric Co., Cleveland, Ohio.
Discussion Organizer — M. L. Trostle, Sylvania Electric Products Inc., Wheeling, W. Va.
A New Look at the Measurement of Light and Color — Deane B. Judd, National Bureau of Standards, Washington, D. C.
Measurement and Specification of Color Rendition Properties of Light Sources — Dorothy Nickerson, Cotton Division, U. S. Dept. of Agriculture, Washington, D. C.
Spectral Luminosity of Fluorescent Lamps — C. W. Jerome, Sylvania Electric Products Inc., Salem, Mass.

(*Continued on page* 31A)

Gold Medal Acceptance Address

(*Continued from page* 25A)

ticular benefit is the stimulation they afford to the student and his future career.

The Public Service Company of Northern Illinois for years sponsored University inspection trips for Illumination students. Through the tireless effort of O. A. Hill, Jr., schedules were arranged which enabled the students, in a four-day trip, to inspect most of the latest lighting installations in the Chicago area. The extent of these trips, and their excellent organization, impressed the students and were the envy of the other students in the power and electronics options.

5. Illumination Students — The student contributes more than any other source to both the pleasure and knowledge in the teaching. His questions and the attempt to explain those things not really understood cause the teacher to follow a course of self-analysis, which frequently corrects some of his own false premises, and explanation, which makes him develop a thorough grounding and evaluation of information. Recently it was noted with pleasure that in one Region 25 per cent of the Section Chairmen were former students of ours. Even more pleasure is derived from the many papers by former students published in ILLUMINATING ENGINEERING. This is the greatest reward any teacher can have. The teaching of these students was not the work of one individual, and these pleasures, the students' success, are shared by my close associates Professors Horn, Miller and Pierce, who contributed much to the development of these individuals. In saying this, there is no intent to detract from the students' own individual ambitions and efforts, which carried them through school and advanced them in their chosen work.

In closing, a few words concerning teaching should be added. The general conception is that the teacher transfers information to the student in a specific field. It must be realized that the teachers have the students in their field only about two and a half months, based upon an actual working week in industry. In class it becomes evident that a University or College is not an information transfer center. The teacher uses the specific field as a tool, but the training given the student should prepare him for any field after his initial apprenticeship in actual practice. The stress is always upon the necessity for continued study, a function which the Society can stimulate with advanced courses of the graduate level, similar to its activity in the elementary work.

Just what does the teacher teach? It was probably best expressed by Sir Richard Francis Burton (1821-1890): "Make it thy business to know thyself, which is the most difficult lesson in the world." The attempt is to make the student analyze himself, measure his possibilities, his ability to assimilate knowledge and apply himself to the task. After this analysis he is taught to accept these abilities given him and, lastly, to use them to his best advantage. The "know thyself" is two-edged in that first the student should study himself and second that he should develop a point of view where he will not accept information without analysis both as to detail and fact, also logic, thereby discovering any false premises which are present. This prepares him for assimilating that which is classified as experience, never obtainable in school. The teacher tries to develop a recognition of three essentials in doing a good job: (1) A maturing of the individual, by advanced study and experience, in wisdom, knowing what is to be done next. (2) The skill in how it is to be done and (3) the all important virtue in what should be done without too much analysis as to "what am I going to get out of it?"

There is one thing that I would like to leave with you. If you like your profession and think that it is a good way of life, be sure to encourage any who are science-minded to consider the pleasures and advantages of Illuminating Engineering. Stress the human element as well as the scientific. Only if enough students register in the courses, are the universities able to offer them. The membership of I.E.S. can guide the high school student toward the profession. The need for illuminating engineers is great and the competition for engineering graduates is such that without some stimulation there will be no place to train them.

In closing, I hope that there is some activity in the Society in which I will be asked to work, thereby continuing to assimilate the knowledge necessary to keep abreast of new developments and meet the inspirations coming from those individuals of various aptitudes that compose our Society.

Again I wish to express my appreciation to the Society and the Awards Committee for considering me for the Medal Award.

Area-lighting system of many moods welcomes office visitors at the New England Mutual Life Insurance Company

New Sylva-Lume wall-to-wall illumination *by* Sylvania

You can custom-create lighting designs like this . . .

using a few standardized components like this

Deep panels • 4 types. In pink, yellow tints, or white

Subtle dashes of color. A warm and pleasant mood. Ceiling décor that almost seems to extend a friendly, "Welcome."

In its own quiet way, new Sylvania *Sylva-Lume* brings all this mood, and good lighting too, to these Boston (Mass.) reception rooms of the New England Mutual Life Insurance Co. It helps also to separate various functional sections of the large room area.

Here New England Mutual uses only one of many possible ceiling designs. Actually, *one in over 100,000* . . . custom-created from a few standardized components . . . using a track grid system based on 36-inch modules. The existing designs can be changed overnight, if desired, by simply shifting the vinyl plastic panels and perforated metal baffles.

New *Sylva-Lume* is a lighting system of unlimited designs and moods, for the designing man of many moods. Developed by a creative group for a creative profession, it allows unlimited freedom of design. By organizing its elements of color, light and form, you can create desired pattern, texture, and style. *Write direct for folder of complete information.*

SYLVANIA ELECTRIC PRODUCTS INC.
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Lighting Division—Fixtures
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. . . fastest growing name in sight

LIGHTING • RADIO • ELECTRONICS
TELEVISION • ATOMIC ENERGY

Shallow panels • 4 types. In same two tints, or white

Drumhead panels • 8 types. White, pink, yellow . . . in several pleasing combinations

Acoustic baffles— White, yellow or blue —delineate and accent

Perimeter panels— Interesting treatment for borders

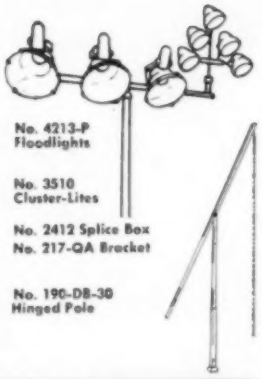
Revere Outdoor Lighting Report

For lighting engineers, lighting planners, and architects interested in outdoor lighting problems and trends

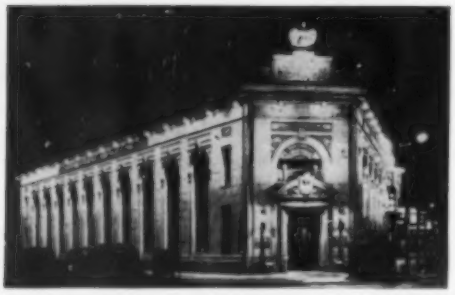
Lighting a Drive-In Restaurant

The Problem: To provide enough light for safe driving and parking of a large volume of traffic; and to provide an attractively illuminated area that readily identifies itself as a drive-in to passing motorists.

The Answer: 3 Revere No. 4213-P floodlights and 5 No. 3510 cluster-lites per pole. Mounting height 33 feet with pole spacing of 24 feet. Cor-ten heavy duty hinged poles No. 199-DB-30 are used to provide convenient maintenance and relamping at ground level.

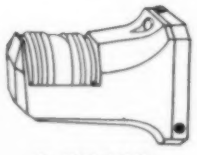


Lighting a Bank Exterior



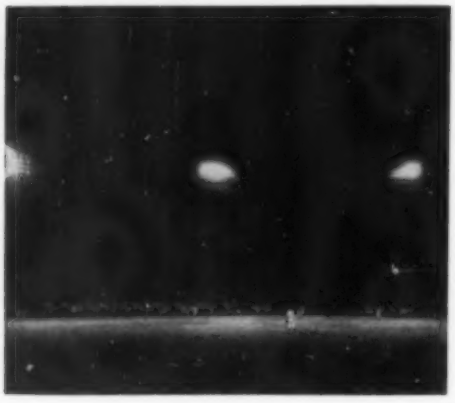
The Problem: To dramatically highlight the impressive architectural style of the building exterior. Fixtures must be attractive, unobtrusive and placed on the building itself.

The Answer: 36 Revere No. 3151-A lights with 180° prismatic control lens give a ratio of maximum to minimum intensity of approximately 3 to 1. Mounting height is 32 feet with spacing of 8 feet between fixtures. Note even light distribution with absence of "hot spots".



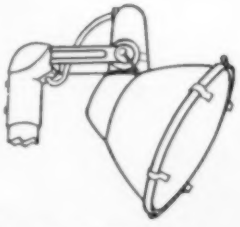
No. 3151-A Light

Lighting a Baseball Field



The Problem: To provide the high level of light necessary for night baseball. Because of the small size of the ball, the speed at which it travels, and the large area of play, baseball demands the greatest intensity of light of all night games.

The Answer: 160 Revere floodlights Nos. 4216-P and 4211-P distributed on 8 poles at 80 feet mounting height. 82 of the lights are No. 4216-P narrow beam with plain lens for concentrating high intensities on the infield and distant mid-field areas. The remainder of the lights (78 No. 4211-P with plain lens) provide a wide beam to illuminate close by zones or the ceiling for fly balls. Combination of wide and narrow beam floodlights provide 20 average footcandles for infield, and 15 average footcandles for outfield.



No. 4216-P Floodlight
No. 4211-P Floodlight

No matter what the lighting problem — if it's outdoors, Revere has the equipment, or can engineer it, to provide your best lighting answer. Write for catalog covering Revere's complete line of matched outdoor lighting equipment.

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Revere Electric Mfg. Co., 6009 Broadway, Chicago 40, Ill., UPtown 8-7100
Available in Canada thru Curtis Lighting, Ltd., Leaside, Toronto, Ontario

(Continued from page 28A)

Tuesday Morning — September 10 (Parallel Sessions)

Residence Lighting Forum

Chairman — Ruth Morris, Georgia Power Co., Atlanta, Ga.

Getting Modern Lighting in a Cooperative Apartment After Construction — Mary Taepke, Detroit Edison Co., Detroit, Mich.

Coordinating Light and Structure in Modern Homes — Eugene Commery, General Electric Co., Cleveland, Ohio.

Luminous Ceilings with Incandescent Lamps — Domina Eberle Spencer, University of Connecticut, Storrs, Conn.

Light Sources

Session Chairman — T. C. Sargent, Sylvania Electric Products Inc., Salem, Mass.

Discussion Organizer — Carl M. Holden, Champion Lamp Works, Lynn, Mass.

Smaller, More Efficient 100-watt Incandescent Lamps — P. B. Jordan, C. W. Pearson and W. H. Fisher, General Electric Co., Cleveland, Ohio.

Glow Discharge Characteristics of Fluorescent Lamps — C. J. Bernier and W .C. Gungle, Sylvania Electric Products Inc., Salem, Mass.

Development of Deluxe Fluorescent-Mercury Lamps for Commercial and Specialized Lighting Applications — W. S. Till, Westinghouse Electric Corp., Bloomfield, N. J.

Design and Characteristics of Fluorescent Lamps Having a Non-Circular Cross-Section — J. O. Aicher and E. Lemmers, General Electric Co., Cleveland, Ohio.

Research

Session Chairman — Benjamin S. Benson, Jr., Benjamin Electric Manufacturing Co., Des Plaines, Ill.

Discussion Organizer — Norman T. Kridel, Rochester Gas & Electric Co., Rochester, N. Y.

Highway Visibility in Fog — Professor Charles Marsh, Pennsylvania State University, University Park, Pa.

Discomfort Glare at Low Adaptation Levels — Multiple Sources — Professor Russell C. Putnam and Keith D. Bower, Case Institute of Technology, Cleveland, Ohio.

Effective Intensity of Flashing Lights — T. H. Projector, National Bureau of Standards, Washington, D. C.

Computation of Effective Intensity of Flashing Lights — C. A. Douglas, National Bureau of Standards, Washington, D. C.

Calculations

Session Chairman — Kurt Franck, Holophane Co., Inc., Newark, Ohio.

Discussion Organizer — Paul H. Lamson, Smithcraft Lighting Division, Chelsea, Mass.

Automatic Processing of Photometric Test Data for Street Lighting — P. A. Zaphyr and G. A. Horton, Westinghouse Electric Corp., Cleveland, Ohio.

Interreflections in Asymmetrical Rooms — Philip F. O'Brien, University of California, Los Angeles, Calif.

Approximations and the Interflection Method — Domina Eberle Spencer, University of Connecticut, Storrs, Conn.

Tuesday Evening — September 10

Lighting Progress Report — J. H. McCulloch, Independent Testing Laboratories, Boulder, Colo., Chairman, I.E.S. Progress Committee.

Wednesday Morning — September 11 (Parallel Sessions)

My Most Interesting Lighting Job Contest

CLASS I — RESIDENCE LIGHTING

Presiding — L. E. Tayler, Detroit Edison Co., Detroit, Mich., Chairman, Lighting Service Committee.

Judges — L. Ralph Bush, E. W. Commery, Myrtle Fahsbender.

Regional Winners

Canadian — D. R. Webb, Maritime Chapter.

East Central — Simon Erlich and David Weisblatt, Maryland Section.

Great Lakes — George E. Matilo, Cleveland Section.

Intermountain — Gerald Joseph, New Mexico Chapter.

Midwestern — Edwin Schnoll, Milwaukee Section.

Northeastern — Sylvan Shemitz, Connecticut Section.

Pacific Northwest — Jack T. Cottingham, Oregon Section.

South Pacific Coast — Al Schramm, San Diego Section.

South Central — Edna Fortier, New Orleans Section.

Southeastern — Jack Murrah, Georgia Section.

CLASS II — COMMERCIAL, INDUSTRIAL AND OTHER

Presiding — C. W. McCormick, Connecticut Light and Power Co., Hartford, Conn., Vice-Chairman, Lighting Service Committee.

Judges — C. L. Crouch, J. M. Ketch, Ted Sargent.

Regional Winners

Canadian — G. Denis, Montreal Section.

East Central — Werner F. Rosacker, Eastern Pennsylvania Section.

Great Lakes — L. T. Genise, Michigan Section.

Inter-Mountain — R. J. Uhl, New Mexico Chapter.

Northeastern — J. F. Barney and Russell Benjamin, Connecticut Section.

Pacific Northwest — B. T. Heinz, Puget Sound Section.

South Pacific Coast — Harold Strahn, Southern California Section.

Southwestern — Earl I. Dinsmore, North Texas Section.

South Central — H. S. Gregory, New Orleans Section.

Southeastern — E. D. Stevens, Tar-Heel Section.

Thursday Morning — September 12 Lighting for TV Production

A First Hand Account of the Adventures in Televising National Events — Walter H. O'Meara, Lighting Director for TV Production, National Broadcasting Co., Chairman, Committee on Lighting for TV Production.

Thursday Afternoon — September 12 (Parallel Sessions)

Street Lighting

Session Chairman — G. K. Glass, Detroit Edison Co., Detroit, Mich.

Discussion Organizer — L. F. Heckmann, Union Metal Manufacturing Co., Canton, Ohio.

Analysis of Light Distributions from Linear Source Street Luminaires — R. G. McPhail, Holophane Co., Inc., Newark, Ohio.

Application Experience with Mercury Vapor Lamps in Street Lighting Service — J. W. Young, New England Power Service Co., Boston, Mass.

Estimating the Cost of a Roadway Lighting System — T. Summers, Jr., Westinghouse Electric Corp., Cleveland, Ohio.

Outdoor Lighting Design for the New York International Airport — Abe H. Feder, Lighting Consultant, New York, N. Y.

Daylighting

Session Chairman — H. B. Vincent, Owens-Illinois Glass Co., Toledo, Ohio.

Discussion Organizer — H. F. Kingsbury, Pittsburgh Corning Corp., Port Allegany, Pa.

A Photographic Method of Brightness Recording — Professors Charles Marsh and Elizabeth Marsh, Pennsylvania State University, University Park, Pa.

Practical Daylighting Prediction — J. W. Griffith, Southern Methodist University, Dallas, Texas; W. J. Arner and O. F. Wenzler, Libbey-Owens-Ford Glass Co., Toledo, Ohio.

Illumination and Brightness with Minute Louvers — W. B. Ewing, Ewing Development Corp., Bay City, Mich.; and R. L. Biesele, Jr., Fenwall, Inc., Ashland, Mass.

Control of Daylighting with Reflecting Jalousies — T. C. Carson, Jr., Blue Ridge Glass Corp., Kingsport, Tenn.

Closing Session

Presiding — J. C. Forbes, Chairman, National Technical Conference Committee.

Report of the Committee on Resolutions — R. F. Hartenstein, Chairman.

CREDIT DUE

Presiding as chairman of this most excellent Conference was Joe B. Browder, assisted as vice-chairman by J. D. Mitchell. They have already received numerous congratulations on the outstanding success of the meeting. If the some 200 committee men and women who participated in the program have not received similar kudoes, they should, and do, herewith. Every phase of the program, from registration onward, revealed by its very "effortlessness" the preparation and conscientious work behind it. Space does not permit detailed bouquets, so many would be required. Suffice it to say that all listed below deserve great credit for a highly successful National Technical Conference.

(Continued on page 32A)

For Next Year's Conference Papers

Deadline for outlines of next year's conference papers is December 31, 1957. The earlier date (August 17-22, 1958) of the National Technical Conference next year has necessitated an earlier deadline for Papers Committee consideration of proposed papers. Those wishing to present papers before the 1958 conference in Toronto should submit outlines not later than December 31, 1957 to:

H. F. Davidson, Chairman, Papers Committee
Curtis Lighting of Canada, Ltd.
195 Wicksteed Ave.
Leaside, Toronto 17, Ont.

(*Continued from page 31A*)

1957 Conference Executive Committee

Chairman, Joe B. Browder
Vice-Chairman, J. D. Mitchell

Miss Emily Alexander	Judd Lough
S. J. Andre	Charles Minors
A. E. Bruner	Mrs. Bruce Moran
Jack J. Burns	Jack H. Murrah
Mrs. L. Ralph Bush	T. Taylor Peake
Cecil L. Cannon	W. M. Pearson
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Mrs. R. J. Kuzell	Harry Yopp

Finance

Chairman, Judd Lough

R. C. Bythewood	Jason W. Elrod

Publicity, Attendance and Printing

Chairman, Jack H. Murrah

Carl W. Evans	Miss Elizabeth Parker
Harold M. Horton	George M. Normandy
	Morris T. Reeves

Entertainment

Chairman, Jack J. Burns

Harold E. Banister	Wm. D. Lanning, Jr.
Miss Nina Faye Bonner	Paul D. Landers
V. H. Branham, Jr.	R. E. Lawler
Ed A. Brown	Logan Van Leigh
H. R. Chappell	W. R. McKinney
Frank Cody	Sy Ostrau
M. Jack Dreyfuss	Miss Elizabeth Parker
Rita S. Kuzell	Charles L. Woodyard

Ladies Reception

Co-Chairmen

Miss Emily Alexander	Mrs. R. J. Kuzell
Mrs. L. Ralph Bush	Mrs. Bruce Moran

Hostesses

Mrs. S. J. Andre	Mrs. W. F. Johnson, Jr.
Mrs. E. R. Bonds	Mrs. J. H. Koen
Miss Nina Faye Bonner	Mrs. Logan Van Leigh
Mrs. Joe B. Browder	Mrs. Judd Lough
Mrs. A. E. Bruner	Miss Olive Massey
Mrs. J. J. Burns	Mrs. D. C. May, Jr.
Mrs. R. C. Bythewood	Miss Margaret McPhaul
Mrs. W. T. Cantrell	Mrs. C. R. Minors
Mrs. John Chastain	Mrs. J. Dixon Mitchell
Mrs. John Claunch	Miss Ruth Morris
Mrs. C. C. Clayton	Mrs. J. H. Murrah
Mrs. H. B. Connell	Miss Frances Myers
Mrs. Hamilton Corey	Miss Lillian Pace
Mrs. R. A. Corvey	Miss Elizabeth Parker
Mrs. Roy Day	Mrs. T. Taylor Peake
Mrs. W. L. Edwards	Mrs. W. M. Pearson
Mrs. Jason Elrod	Mrs. A. D. Perkins
Mrs. C. G. Fulton	Mrs. J. J. Perry, Jr.
Mrs. Carl H. Fulton	Mrs. Perry Sessoms
Mrs. J. L. Harper	Mrs. O. V. Scott
Mrs. Ray Hiller	Mrs. W. I. Vawter
Mrs. Charles Howe	Mrs. May West
Mrs. D. K. Humphrey	Mrs. H. J. Wilson
Mrs. Opal Jackson	Mrs. Harry Yopp
Mrs. Paul W. Jeans	Mrs. H. G. Youngblood

Transportation

Chairman, T. Taylor Peake
Vice-Chairman, W. T. Cantrell

Robert J. Kuzell	Paul P. Harrison
Ray H. Hiller	Edgar D. Johnson
V. H. Branham, Sr.	Robert A. Corvey
J. J. Perry, Jr.	Preston E. Newman
Louis O. Williams, Jr.	T. A. Bartenfeld, Jr.
	Walter S. Smith

Hotel

Chairman, J.E. Sweatte

Subcommittee on Reservations and Registration

Chairman, S. J. Andre

Oren M. Ruff	Howard B. Connell
C. C. Sweatman, Jr.	Walter W. Wildeman
J. Tom Pyron	J. O. Hammond

Subcommittee on Audio-Visual

Chairman, Thomas W. Haslam

Jim H. Koen	Jason W. Elrod
Wesley F. Johnson	W. Wray Buchanan
D. Kenneth Humphrey	Charles G. Fulton
James W. Brown	Jerry F. Fudge
Melvin E. Hunt, Jr.	D. C. May, Jr.

Subcommittee on Conference and Committee Rooms

Chairman, Charles R. Minors

Ernest L. Bell	Johnny Brun
Paul W. Jeans	Herbert L. Reed
A. H. Lundstrom	Howard B. Connell
J. William Stone III	E. Warren Althouse
	H. Robert McClellan

Subcommittee on Special Lighting and Decorations

Chairman, Harry T. Yopp

W. L. Hilton, Jr.	John E. Anderson, Jr.
H. Hugh Foster	Carl H. Fulton
Douglas L. Wells	Fred F. Bainbridge
Alan L. Ferry	Howard L. McKinley

Sports

Chairman, Alfred E. Bruner

R. L. Carmichael	William I. Vawter
Guy Johnson	Bert L. Trapani

Reception

Chairman, Cecil L. Cannon
Mr. and Mrs. Hamilton Corey
Mr. and Mrs. O. V. Scott
Mr. and Mrs. R. A. Arthur
Mr. and Mrs. Ray H. Hiller
Mr. and Mrs. Perry G. Sessoms, Jr.
Mr. and Mrs. Robert A. Corvey
Mr. and Mrs. William M. Pearson
Mr. and Mrs. Walter C. Fink, Jr.
Mr. and Mrs. Joe B. Browder
Mr. and Mrs. Cecil L. Cannon

South Central Region

George L. Morris, Vice-President

Southeastern Region

J. Dixon Mitchell, Vice-President

Georgia Section

Chairman, William M. Pearson
Vice-Chairman, Walter C. Fink
Secretary-Treasurer, Thomas W. Haslam
Managers: S. J. Andre, Judd Lough, Johnny Brun, L. J. Campbell

I.E.S. National Technical Conferences

1958 — August 17-22 — Royal York Hotel, Toronto, Ontario
1959 — September 7-11 — Hotels Fairmont and Mark Hopkins, San Francisco, California
1960 — September 11-16 — Penn Sheraton Hotel, Pittsburgh, Pennsylvania
1961 — September 24-29 — Chase Park Plaza Hotel, St. Louis, Missouri
1962 — September 9-14 — Statler-Hilton Hotel, Dallas, Texas

Chicago Lighting Institute Opens New Headquarters

Some 250 lighting and electrical industry notables from Chicago and the nation attended the formal opening luncheon and dedication of the new Chicago Lighting Institute headquarters at 140 South Dearborn St., on October 3. A luncheon preceding the opening inspection tour took place in the Red Lacquer Room of the Palmer House, with introductions of principal speakers and others by Ole A. Hill, Jr., President of the Institute.

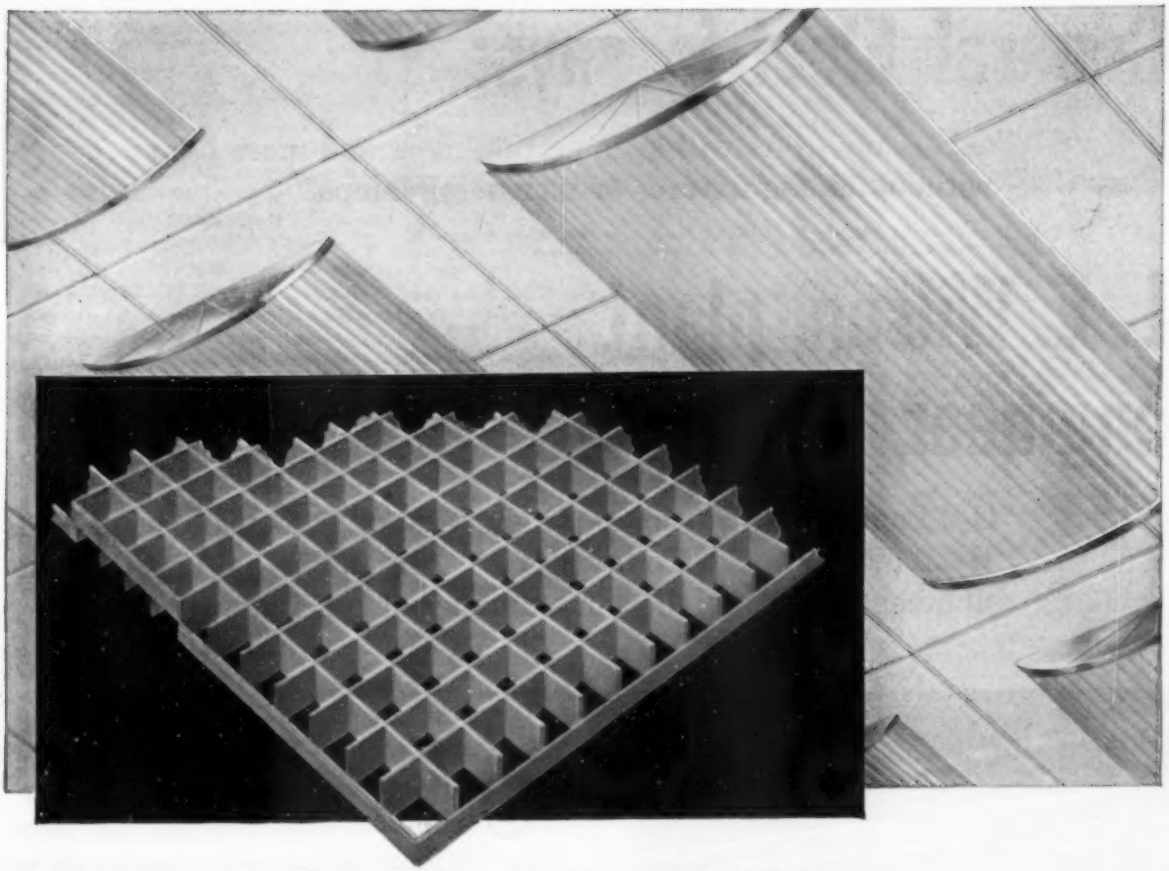
After the invocation by Dr. Martin Koeneke of Concordia College, the principal speaker was Thomas G. Ayers, Vice-President, Commonwealth Edison Co., who talked on the background of the Institute and its hope and promise for the future in the new headquarters. He was followed with brief remarks by Kirk Reid, President of I.E.S., and Ivar Viehe-Naess, Project Manager for Shaw, Metz and Dolio, consultants on the Institute project.

Winner of the 1957 Chicago Lighting Institute Citation Award, Dr. John O. Kraehenbuehl, was introduced and received the ward from R. J. Diefenthaler, Secretary-Treasurer of the Institute. Dr. Kraehenbuehl is also the 1957 recipient of the I.E.S. Gold Medal. In accepting the award, he referred to his many years of teaching the illumination option at the University of Illinois, and introduced several of his students present at the luncheon. His first graduate was Mr. Diefenthaler.

From the luncheon, the group proceeded to the new Institute quarters, where they were divided into several smaller groups to facilitate the inspection tour. The first section inspected was the Light Center, elliptical lecture hall which seats 150, completely equipped for visualization of lighting fundamentals and application. Here Carl Zersen, Managing Director, demonstrated the lighting by incandescent, fluorescent and mercury vapor luminaires, all circuited through an elaborate control panel containing complete master circuits as well as dimming.

The school classroom lighting area was demonstrated by Kerr Sanders of the In-

(*Continued on page 35A*)



NEW FROM KOPPERS—

EVENGLO® light-stabilized polystyrene in COLORS

NOW YOU CAN SATISFY your customers' demand for colored lighting fixture components.

Koppers is offering new EVENGLO light-stabilized polystyrene in a wide variety of soft pastel shades. Lighting fixture grills, panels and shields can now have lasting, molded-in color to permit the desired hue, tone and soft tint in office, showroom and other commercial interiors.

This high quality, premium product meets Class C requirements of SPI-IES, "Proposed Property Specifications for Polystyrene Used in Fluorescent Luminaires." You can expect EVENGLO polystyrene to remain new and bright-looking far longer than any ordinary types.

Fadeometer and S-I sun lamp tests have proven the superior resistance of EVENGLO light-stabilized polystyrene to discoloration. Koppers application engineers will welcome your inquiries, and are ready to work with you. Write today for further information on the properties and light transmission characteristics of this interesting new EVENGLO polystyrene for lighting that is now supplied in pastel colors.

Koppers Company, Inc., Dept. IE-117, Chemical Division, Pittsburgh 19, Pennsylvania.

Offices in Principal Cities • In Canada: Dominion Anilines and Chemicals Ltd., Toronto, Ontario

KOPPERS

KOPPERS PLASTICS

General Electric says:

"G-E Lamp users will keep getting more and more light . . . without adding fixtures or increasing lamps."

L. E. Wilson, plant engineer, says:

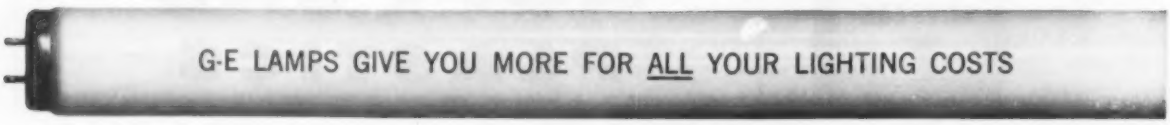
"G-E Lamps gave our plant a light level of 23 footcandles in 1943. By 1950 it was 30. Today it's 40! And we're using the same number of fixtures, the same number of G-E Lamps!"

"G-E Lamps have kept this lighting installation up to date at no extra cost," says L. E. Wilson of Cleveland Graphite Bronze Company (division of Clevite Corporation.) William Bode (right), utilities engineer, checks light level with H. D. Hanson, safety director.

ONE of the surest ways to make certain your customers get full value for all their lighting costs is for you to specify G-E Lamps *exclusively*. Then you know their lighting system is being kept up to date because the lamps contain the latest improvements from General Electric research. Customers who have used the G-E 40-watt fluorescent lamp, for instance, are getting 30% more light today than they did in 1950—from the same fixtures, the same wattage. Across the board, today's G-E Lamps give your customers more for all their lighting costs. General Electric Co., Large Lamp Dept. IE-117, Nela Park, Cleveland 12, Ohio.

Progress Is Our Most Important Product

GENERAL ELECTRIC



(*Continued from page* 32A)

stitute. In this sector, which is equipped as to furniture, floor covering, chalk boards, walls, to meet the highest lighting standards, several different combinations of luminaire types and daylighting may be simulated. Windows along one wall have 1000-watt floodlamps behind them which may be controlled to show the effect from full sunlight to deepest dark. The industrial area, demonstrated by Ray Wozniak, again showed the several different types of industrial luminaires now in common use.

The actual offices of the Institute are illuminated and decorated to conform with good practice and serve as demonstration areas as well as for practical every-day use.

Of special interest is the foyer of the new headquarters, which has the "world's first" application of Plexiglas edge-lighting over the entire ceiling, distinctively diffierent in luminous ceilings. The Gallery of Light is a corridor 100 feet long and approximately 25 feet wide in which many types of luminaires, both incandescent and fluorescent, from residence on through industrial and outdoor street lighting, are displayed. These fixtures are all suspended from energized duct for individual display and easy changing.

The new facilities of the Institute will be in use with the annual lecture and laboratory Lighting Fundamentals Course, which began October 14, and Wiring Design No. 1, which began October 15. An Industrial Lighting Clinic, full-day meeting, is scheduled for December 3.

California Lighting Course Goes On the Road

A ten-session course in Practical Illumination, with four locations for each session, is being sponsored in California by the Golden Gate Section, the San Jose Chapter and the Mother Lode Chapter of I.E.S. Speakers are from the Golden Gate Section.

Weekly schedule for the two-hour classes is:

Mondays — The Little Theater, Abraham Lincoln High School, San Jose.
Tuesdays — Builders Exchange, Stockton.
Wednesdays — Western Merchandise Mart, San Francisco.
Thursdays — IBEW, Local 6, 55 Fillmore St., San Francisco.

The combined visual and lecture course includes sound slide films, motion pictures, slides of outstanding installations as well as demonstrations of light sources, control methods and basic principles. Topics and speakers are:

September 23-26 — Lighting Fundamentals, M. O. Bunker and F. E. Duhme.
September 30-October 3 — Incandescent Lamps, Henry J. Soubielle.
October 7-October 10 — Fluorescent Lamps, Leonard A. Komor.
October 14-17 — Light Control, Arthur S. Tylor.
October 21-24 — Lighting Fixtures, Dick Leopold.
October 28-31 — Design Fundamentals, George M. Baker.
November 4-7 — Design Layouts, C. T. Bakeman.
November 11-14 — Industrial Lighting and Floodlighting, John C. Epperson.
November 18-21 — Store Lighting, Robert L. Sawyer.
December 2-5 — Office and School Lighting, C. W. Macy and F. E. Duhme.

The San Jose sessions are being handled by William Addison, Pacific Gas & Electric Co.; the San Francisco sessions by Frank E. Duhme, Jr., Smoot-Holman Co.; the Stockton meetings by Elton Harhis, Sacramento Municipal Utility District and Earl E. Storrs, Industrial Electrical Consultants; the IBEW sessions by Charles Foehn of Local 6.

I.E.S. Recommended Practices, reprints of pertinent articles, engineering and design data are supplied. Tuition for the ten lectures is $15.

SCHEDULED EVENTS

November 11-15, 1957 — National Electrical Manufacturers Association, Traymore Hotel, Atlantic City, N. J.

November 18-21, 1957 — 10th Exposition of the Air-Conditioning and Refrigeration Industry, Navy Pier, Chicago, Ill.

December 1-6, 1957 — The American Society of Mechanical Engineers. Annual Meeting, Hotel New Yorker, New York, N. Y.

December 12, 1957 — Council Meeting, I.E.S., New York, N. Y.

January 27-29, 1958 — American Society of Heating and Air-Conditioning Engineers, Incorporated, Annual Meeting, Pittsburgh, Pa.

February 3-7, 1958 — American Institute of Electrical Engineers, Winter General Meeting, New York, N. Y.

February 9-15, 1958 — National Electrical Week.

February 13, 1958 — Council Meeting, I.E.S., New York, N. Y.

February 20-21, 1958 — 14th Annual National Wiring Promotion Conference, Statler Hotel, Detroit, Mich.

March 2-5, 1958 — National Electric Sign Association, National Convention, Shamrock Hilton Hotel, Houston, Texas.

April 10-11, 1958 — Northeastern Regional Conference, Statler Hotel, Hartford, Conn.

April 14-15, 1958 — East Central Regional Conference, John Marshall Hotel, Richmond, Va.

April 24-25, 1958 — South Central and Southeastern Regional Conference, Lafayette Hotel, Little Rock, Ark.

April 28-29, 1958 — Southwestern Regional Conference, Hotel Washington Youree, Shreveport, La.

April 30, 1958 — Council Meeting, I.E.S., Hotel President, Kansas City, Mo.

May 1-2, 1958 — Midwestern Regional Conference, Hotel President, Kansas City, Mo.

May 8-9, 1958 — Inter-Mountain Regional Conference, Whitman Hotel, Pueblo, Colo.

May 14-15, 1958 — South Pacific Coast Regional Conference, El Cortez Hotel, San Diego, Calif.

May 22-24, 1958 — Pacific Northwest Regional Conference, Multnomah Hotel, Portland, Oregon.

June 9-13, 1958 — National Association of Electrical Distributors, 50th Annual Convention, San Francisco, Calif.

June 12, 1958 — Council Meeting, I.E.S., New York, N. Y.

June 23-24, 1958 — Great Lakes Regional Conference, Sheraton Hotel, Rochester, N. Y.

June 23-27, 1958 — American Institute of Electrical Engineers (Summer General Meeting), Buffalo, N. Y.

August 17-22, 1958 — Illuminating Engineering Society (National Technical Conference), Royal York Hotel, Toronto, Canada.

August 19-22, 1958 — American Institute of Electrical Engineers, Pacific General Meeting, Sacramento, Calif.

October 13-15, 1958 — National Electronics Conference, Inc., Hotel Sherman, Chicago, Ill.

October 20-24, 1958 — National Safety Council (46th National Safety Congress & Exposition), Chicago, Ill.

October 27-31, 1958 — American Institute of Electrical Engineers (Fall General Meeting), Pittsburgh, Pa.

November 10-14, 1958 — National Electrical Manufacturers Association (Annual Meeting), Traymore Hotel, Atlantic City, N. J.

Council Meetings Listed For 1957-1958 Year

Meetings of the I.E.S. Council for the year 1957-1958 have been scheduled as shown below. Members of the Society are free to attend any of these meetings as guests, or may submit a communication, for consideration on any matter, through their Regional Vice-President or the General Secretary at Headquarters.

December 12, 1957 — New York, N. Y.
February 13, 1958 — New York, N. Y.
April 30, 1958 — Kansas City, Mo.
June 12, 1958 — New York, N. Y.

(*Continued on page* 36A)

(Continued from page 35A)

Applications for Retired Membership

New retired membership classifications became effective in the fiscal year beginning October 1956. Privileges in these new grades, earned by long membership in the Society, include reduced annual dues ($5.00) with continued receipt of all Society mailings including ILLUMINATING ENGINEERING. Such members will be designated as Member, Retired; Associate Member, Retired.

Those who are interested and qualified (at least thirty years of membership and 65 years of age) should write to the General Secretary at Society Headquarters, stating that they have retired from regular occupation in business or profession.

James M. Ketch Retires

James M. Ketch, illuminating engineer with General Electric's Large Lamp Department and Fellow of I.E.S., retired September 30 from active duty with his company.

Mr. Ketch is widely known throughout the country as author of numerous papers presented before I.E.S. Conferences and published in ILLUMINATING ENGINEERING, as speaker at countless meetings across the nation, as "father" of the "three-second selling" concept in store

James M. Ketch

lighting and as an authority on office, school and store lighting.

Most of Mr. Ketch's 40 years with General Electric have been at Nela Park, where he was Supervisor of lighting for office, school and public buildings in the Large Lamp's Application Engineering staff at the time of his retirement. In past years he has been active in training programs for young engineers entering the illumination field.

His contributions to I.E.S. have been many: as Vice-President of the Society in 1926-1928; Treasurer, 1944-1945; and Director, 1945-1948. An active factor in the formation of quite a few Chapters in several sections of the country, Mr. Ketch was Chairman of the Michigan Section (then Detroit Chapter) in its Charter year of 1923. He has been a member of I.E.S. technical committees in his special fields and is currently serving as Chairman of the Subcommittee on Lighting in Museums and Art Galleries.

Gold Medal Nominations Due by January 1

Nominations of candidates for the 1958 Gold Medal Award are being sought by the Medal Award Committee, for consideration for next year's award. Such nominations must be received at Society Headquarters by January 1, 1958.

Candidates need not be members of the Society or citizens of the United States or Canada. They may be nominated at any time by any member of the Society, by sending to the General Secretary at Society Headquarters the name of the individual deemed worthy of the award.

Plans in Development for Plastics Institute

The Society of Plastics Engineers, through its President, Peter W. Simmons, has appointed Jerome Formo chairman of a special committee to develop plans for the formation of a Plastics Institute. This institute would serve the plastics industry in much the same way as the textile, rubber, glass, steel and other

(Continued on page 39A)

Attention I.E.S. Members — A Share the Wealth Message

Membership in I.E.S. pays off with many advantages and satisfactions, some of which are listed below. But these rewards are of the type which increases with both increased membership and increased activity by those already belonging.

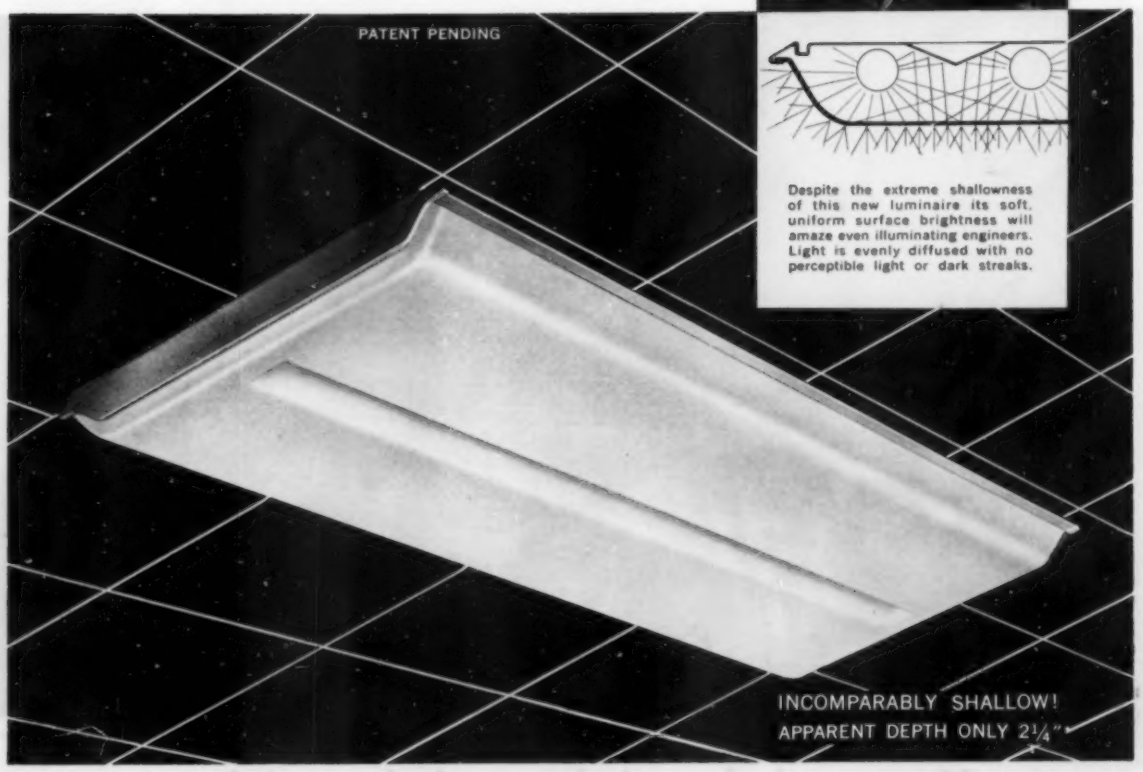
The National Membership Committee invites you to share the benefits you receive from your membership in the Society by seeking to bring others in your area to enjoy the following advantages.

- Valuable Contacts. Here it is obvious that a wider membership provides more varied, and more useful, attendance at Section and Chapter meetings. I.E.S. members get acquainted with people from all segments of the lighting industry and profession: from research, teaching, application, specification, manufacture, distribution to final installation and use.
- Lighting Trends and Information. Through lectures and forums sponsored by their Section, Chapter or Region, I.E.S. members get information on current and developing lighting techniques.
- Monthly Magazine. The Society's journal ILLUMINATING ENGINEERING includes in addition to the literature of lighting — Recommended Practices, reports, conference papers — articles and up-to-date information on the practical everyday application of lighting knowledge.
- Lighting Library. I.E.S. members have access to a complete selection of the publications of our Society; reference material for all current lighting application problems.
- Recognition. From the platform at local, regional or national meetings, I.E.S. members can present their own views, studies and contributions to the science or to the practical application of lighting. On I.E.S. technical committees they may contribute to the making of recommendations.
- Participation. The satisfaction of working together with others in your field is by no means the least of the advantages of I.E.S. membership.

We invite you to invite others to join I.E.S. Membership blanks are available from your local Membership Committee.

1957-1958 NATIONAL MEMBERSHIP COMMITTEE.

IT'S SURFACE MOUNTED—BUT LOOKS RECESSED!



Despite the extreme shallowness of this new luminaire its soft, uniform surface brightness will amaze even illuminating engineers. Light is evenly diffused with no perceptible light or dark streaks.

The Fixture Setting Amazing New Latitudes in Lighting

THE

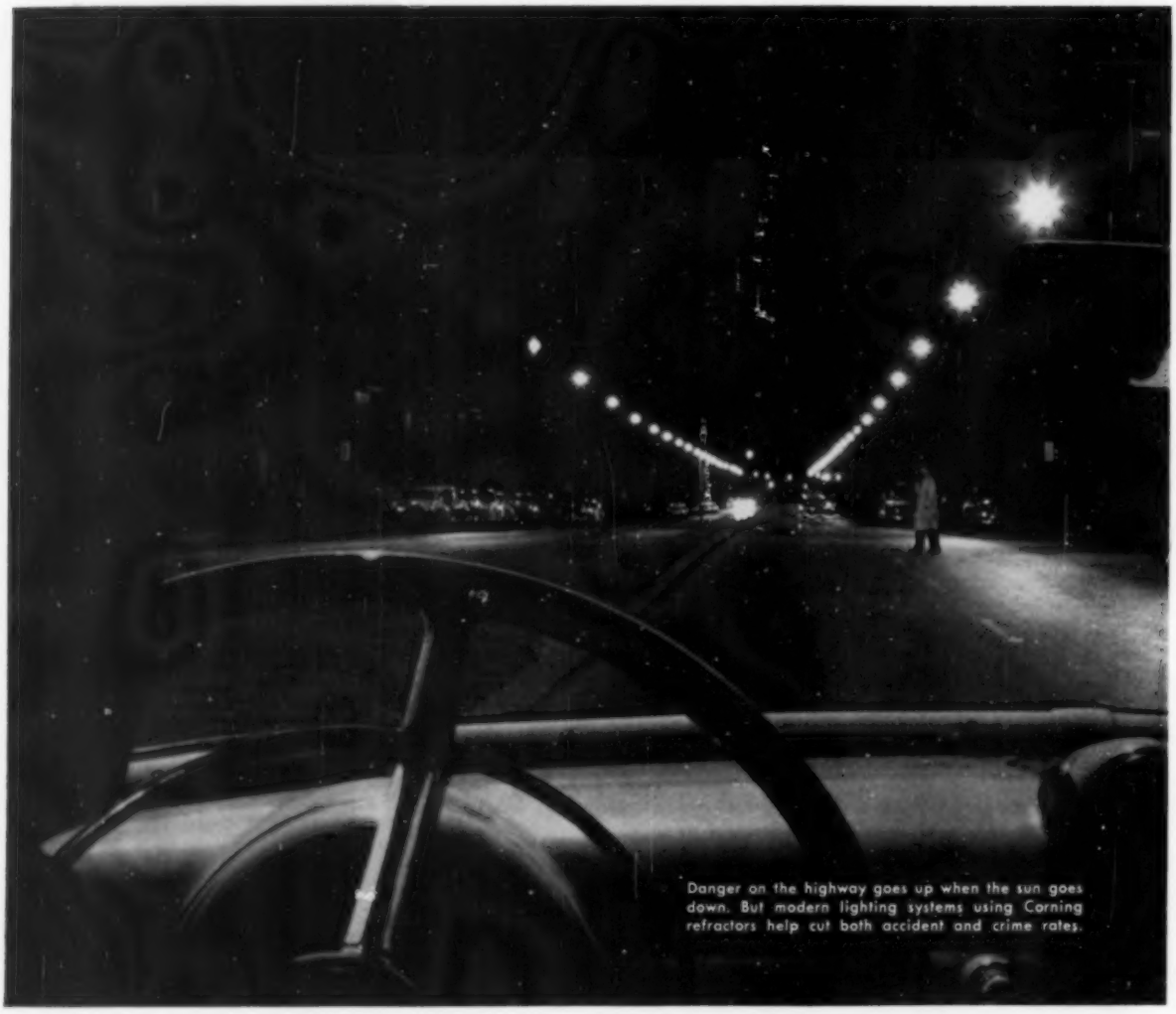
SHALLORAMA®

- 2- and 4-lamp units for widest range of applications; banks, institutional spaces, general or private offices, etc. Ideal for re-lighting.
- No latches, no hinges, no visible hardware. Installs lightning-fast.
- Diffuser opens on continuous hook-up supports by hand from either side.
- Fully enclosed by attractively contoured, micro-embossed, matte white Plexiglas, requiring minimum maintenance.

Sent for Bulletin 763-A yet?

SUNBEAM Visionaire Lighting Company

SUNBEAM LIGHTING COMPANY, 777 EAST FOURTEENTH PLACE, LOS ANGELES 21, CALIFORNIA
SUNBEAM LIGHTING CO., INC., 3840 GEORGIA STREET, GARY, INDIANA



Danger on the highway goes up when the sun goes down. But modern lighting systems using Corning refractors help cut both accident and crime rates.

You and the night and the *mishaps*

Your stake in proper street and highway lighting is a double one.

First you observe and evaluate from your professional background. Then you almost invariably must judge as a public-minded citizen.

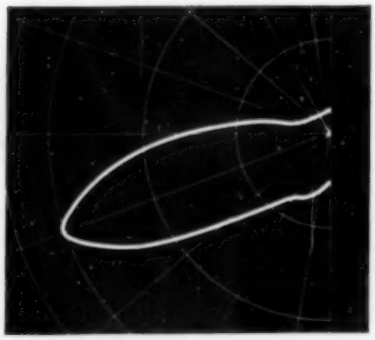
Is this lighting that you live with up-to-date and adequate? Is it doing the job you know the *right* light can do—cutting accident rates, reducing crimes, making life more pleasant for those who are about after dark?

The evidence is everywhere: *Good lighting is a vital step in defeating the dangers that lurk in the dark.*

And a number of leading manufacturers of street lighting equipment come to Corning for glassware that satisfies all their optical and mechanical requirements.

In fact those who make light do man's bidding have long looked to Corning for assistance in both engineering and production.

Inquiries concerning your particular interests are invited. Write to: Lighting Sales Department. You will hear from us promptly.



Lateral distribution of I.E.S. Type III luminaire used in installation pictured above.

Corning means research in Glass **CORNING GLASS WORKS,** 33-11 Crystal Street, Corning, N. Y.

(Continued from page 36A)

basic product institutes serve their respective industries.

The Plastics Institute will provide facilities for research both fundamental and development, education for those in any branch of the industry and a library for reference and study. All segments of the industry — fabricators, material suppliers and equipment builders — will be invited to participate in its program and facilities.

For further information, contact Jerome Formo, Chairman of the Plastics Institute Committee, 2753 Fourth Ave., South, Minneapolis 8, Minn.

The User Speaks At Golden Gate Meeting

Tours of the new Fireman's Fund Insurance Co. building in San Francisco, plus an opportunity to hear the customer's viewpoint on good lighting, attracted nearly 200 members and guests to the September 19 meeting of the Golden Gate Section, I.E.S. Guest of honor and one of the speakers was Fred H. Merrill, vice-president of the Fund, who had a convincing story to tell about the advantages of quality lighting.

Mr. Merrill outlined the company's approach to the lighting environment, which included a specially designed system by Dan Finch, in cooperation with architect Edward B. Page and electrical engineer Clyde Bentley. Egg-crate louvers are mounted below the fluorescent units which have diffusers of their own. Reflectances were considered of top importance, with care in the choice of colors of all furnishings and decoration — even of the telephones.

Also at this meeting, the Section's gavel changed hands, being presented to incoming Chairman C. W. Macy by outgoing Chairman Guy de Leuze.

NEW Committee Distributes Planning Guide

Final plans for the February 9-15, 1958, observance of National Electrical Week have been announced by Merrill E. Skinner, vice-president of Union Electric Co. and chairman of the NEW Committee.

Approximately 4500 planning guides and kits of materials are being sent to industry leaders representing power suppliers, manufacturers, distributors, contractors, dealers, city inspectors, the electrical industry press, electrical leagues and associations and electrical unions. In addition, copy and planning material is being sent to some twenty companies in allied industries, such as chemical, aluminum, copper, steel and rubber, that have indicated an interest. The national committee expects more than 250 community committees to be formed during the coming months to carry out locally coordinated programs.

Obituary

Albert H. Clarke, Fellow of the Illuminating Engineering Society and vice-president of Crouse-Hinds Co., died October 9 of a heart attack. He was 54 years of age.

Mr. Clarke's entire professional career was with Crouse-Hinds, whom he joined as a sales application engineer in 1925.

Albert H. Clarke

He was a pioneer in many early applications of sports lighting and in the development of lighting for airports and airways. At the time of his death he was vice-president in charge of manufacturing for his company.

A member of the I.E.S. Aviation Lighting Committee from 1936 and of the Sports and Recreational Area Lighting Committee from 1946, Mr. Clarke has also served on other of the Society's technical committees. He was a member of several of the technical committees of the United States National Committee of the International Commission on Illumination and was the author of many articles on subjects of floodlighting and airport lighting. He was currently a member of the I.E.S. Board of Fellows and the Advance Planning Committee.

In recognition of his contributions to lighting, he was made a Fellow of I.E.S. in 1955. He was a member of the Ameri-

(Continued on page 40A)

CHAIRMAN'S gavel, in photo at left, is presented to C. W. Macy by outgoing Chairman Guy de Leuze of the Golden Gate Section, I.E.S. Clyde Bentley looks on. In photo at right, Fred H. Merrill, vice-president of Fireman's Fund Insurance Co., tells why his company wanted emphasis on top quality lighting. Attendance was nearly 200.

(*Continued from page* 39A)

can Institute of Electrical Engineers, International Association of Electrical Inspectors and the National Electrical Manufacturers Association.

Deaths

Louis Goetz, New England Section.
Fred Knudsen, Mother Lode Chapter.
Elmer Prag, Past-Chairman, Central Oklahoma Section.

ABOUT PEOPLE

FORMER Regional Vice-President of the South Pacific Coast Region, at right in both photos, does the honors as left, he presents a certificate for meritorious service to outgoing Chairman of the Southern California Section G. A. Hochenauer, and at right, the gavel of office to incoming Chairman Roy Bevan. Presentations were made at the Section's September 4 meeting.

Westinghouse Lamp Division has organized a new Rayescent lighting group for development, application and sale of electroluminescence. Under the new organization, **Carl F. Jensen** will be responsible for all sales activities, reporting directly to the division sales manager. **George B. Saviers** has been placed in charge of lamp manufacturing, and **William J. Knochel** of lamp engineering. Applied research activities will be headed by **Dr. John W. McNall** and basic research on electroluminescence will continue under the direction of **Dr. Henry J. Ivey.**

The Board of Directors of Benjamin Electric Manufacturing Co., Des Plaines, Ill., have announced changes in their top level officers. **Hoyt P. Steele,** who has served as President of the company for the past three years, has resigned this post to be available for other opportunities, but will continue as a Director of the company. Succeeding Mr. Steele as President is **John R. Bartizal,** who is also Chairman of the Board. **Arthur E. Swedenborg** has been elected as Vice-President in Charge of Sales; **J. H. Fall, III,** as Vice-President and Treasurer, and **George A. Hamm** as a Vice-President, continued to serve as Secretary.

Seriously injured in an automobile accident, September 18, **Carl Atherton** is in the Concord, N. H. Hospital.

Forrest C. Fisher has been appointed general manager of the General Electric Co.'s Ballast Department at Danville, Ill., succeeding **C. P. Hayes,** who has been named general manager of the company's Circuit Protective Devices Department in Plainville, Conn. Prior to this appointment, Mr. Fisher was manager of manufacturing for the General Purpose Control Department at Bloomington, Ill.

CERTIFIED Lighting is discussed by Electric League managers and special guests who attended the Second Conference of Certified Lighting Bureau Administrators at the Hotel Sinton, Cincinnati, October 1.

The Progress Medal Award, highest honor of the Society of Motion Picture and Television Engineers, has been presented to **Ralph M. Evans,** Director of the Color Technology Division, Eastman Kodak Co. The gold medal representing the award was presented on October 4 during the SMPTE Semiannual Convention in Philadelphia. The award is given anually in recognition of research invention or development which results in a significant advance in the development of motion-picture technology. Mr. Evans has received the honor for his achievements in motion-picture color films and in the art of color photography generally.

Don P. Caverly, who was with Sylvania Electric Products Inc. for the past twenty years, has accepted a position as Director of Engineering and Development of Harvey Hubbell, Inc., Bridgeport, Conn. In this newly-created position, Mr.

(*Continued on page* 42A)

HOW Westinghouse

JOB-TAILORED FLUORESCENT LAMPS MEET YOUR LIGHTING NEEDS

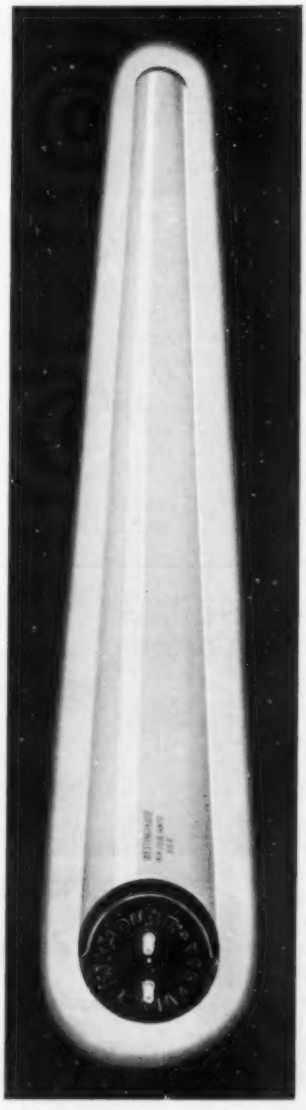
...all with ULTRALUME™ High-Intensity Phosphors • MORE LUMENS PER WATT... more light for your dollar • UNIFORM END-TO END LIGHT • PERFECT COLOR MATCH...ALWAYS • MAXIMUM OUTPUT MAINTAINED THROUGHOUT LONG LIFE

1. New SUPER-HI Fluorescent lamps produce more than twice the light per foot. Designed primarily for high bay (20 feet or higher) industrial and outdoor lighting, a new line of extra high light output fluorescent lamps produce more than twice as much light output per foot as standard fluorescent lamps. The new SUPER-HI lamps permit extremely high energy loading of electrodes, the arc stream and the phosphor. This gives you high light output with new economy at good efficiency and long life.

SUPER-HI lamps are light in weight, convenient to handle and provide a light source subject to the same easy optical control as with present standard T12 lamps, but with over twice the light output. Available in 105, 155, and 205 watts, 4, 6 and 8 ft. The lamps have a rated average useful life of 5000 hours, deliver 6000 to 13,000 initial lumens.

2. High Output Rapid Start lamps give more than 50% more light than regular type. Designed primarily for medium-high bay (15 to 20 feet) industrial and outdoor lighting, four new sizes of Westinghouse high output, rapid start fluorescent lamps can produce over 50% more light than comparable sizes of regular lamps and offer new economy and effectiveness to fluorescent lighting. These lamps provide increased lighting levels, make installations with adequate footcandle values of deluxe color light more practical, and improve the economy and practicability of fluorescent lighting at higher mountings and at lower ambient temperatures.

These lamps are available in 24", 48", 72" and 96" T12 design for general indoor use and for outdoor service where retention of light output at low temperatures is essential. The 72" T12 is recommended for street lighting.



3. Reflector-Fluorescent lamps produce 60% more directed light. For use where external reflectors are difficult or impractical to use, or where dirt deposit cuts lighting effectiveness, these Westinghouse Reflector-Fluorescent lamps provide a directional light distribution which helps put the light where you want it. This is accomplished by a built-in reflecting surface, extending the length of the lamp on the inside of the tube, which redirects about 60% extra light out the other side. Westinghouse Reflector-Fluorescent lamps are recommended for use in coves, showcases and other locations where space is limited. Indirect lighting effects may also be obtained by aiming the lamps toward the ceiling.

They also solve special lighting problems including temporary lighting for construction projects, displays, and exhibits.

Westinghouse Reflector-Fluorescent lamps are available in 40 watt rapid start, 48" and 96" T12 slimline types.

4. Beauty Tone™ Home-line Fluorescent lamps with warm white deluxe color. The same new Westinghouse "Beauty Tone Home-line" lamps which are revolutionizing home lighting by providing warm white deluxe illumination are also ideal for offices, stores and wherever "friendly" color of light is wanted to flatter complexion, enhance the natural color of furnishings, decorations, and displays, and blend well with incandescent lighting.

There's a network of Westinghouse distributors ready to serve you. Call your nearest Westinghouse Supplier for a free Job-Tailored Survey of your lighting requirements. Or write Westinghouse Lamp Division, Bloomfield, N. J.

YOU CAN BE SURE...IF IT'S Westinghouse

(Continued from page 40A)

Caverly will direct all engineering and product development activities for this manufacturer of wiring devices.

Realignment of the marketing organization of General Electric's Outdoor Lighting Department, Hendersonville, N. C., has been announced. Under the new organization, the following component managers have been appointed: **R. J. Swackhamer,** User Industries Sales; **E. G. Wendling,** Component and Intermediate Distribution Sales; **C. K. Fulton,** Propositions, Quotations and Bids; **W. E. Schwanhausser,** Application Engineering; **J. C. Boyter,** Advertising and Sales Promotion; **S. H. Walker,** Marketing Administration and Personnel Development. **K. D. Tobin** has been named acting manager of Product Planning, Service and Marketing Research.

The election of **Edmond C. Powers** and **Robert L. Baumgardner** as Vice-Presidents has been announced by the Griswold-Eshleman Co. Mr. Powers, who has been Manager of the agency's Public Relations Department for 23 years, will continue to serve in this capacity. Mr. Baumgardner will also continue to serve in his present capacity as a Group Head.

Lester E. Barrett, President of the Barrett Electrical Supply Co., St. Louis, Mo., has been elected chairman of the National Wiring Bureau, succeeding **Carl T. Bremicker,** Northern States Power Co., who has been chairman since 1955.

Ruby-Philite Corp., Long Island City, N. Y., has appointed **W. C. Evans** and Associates, Fort Lauderdale, Fla., as sales representatives for all of Florida with the exception of the western peninsula.

Ruby-Philite also announces the appointment of the E. C. Baumann Co., Chicago as their sales representatives. The company is operated by **Robert Baumann** and **W. H. Baumann.**

The Leadlight Fixture Co., Oakland, Calif., has named **George E. Mitchell, Jr.,** as Sales Engineer for the Bay area. Mr. Mitchell's background is in residential and commercial construction experience.

Appointment of **Brown W. Saveland** as The Austin Co.'s assistant district manager in the Pacific Northwest has been announced. Mr. Saveland has his headquarters in Seattle, Wash.

Curtis Lighting, Inc., has appointed Hawn & Stear, Inc., 2666 West Liberty Ave., Pittsburgh, Pa., as sales representatives. **W. Myrton Hawn** will represent the company in the Pittsburgh area and **Ralph H. Stear** in the West Virginia area.

Jack H. Riley, of Jack Riley Associates, has been named as representative for The Miller Co. in the Chicago area. **Richard G. Vacca,** who has been representing the company in the territory, has joined Jack Riley Associates and will continue in this activity.

The Edwin F. Guth Co. announces the appointment of **John T. Fite, Jr.,** 738 Land Title Building, Philadelphia, Pa., as lighting sales engineer for southeastern Pennsylvania, southern New Jersey and northeastern Delaware. Mr. Fite was previously a district sales engineer for Litecontrol Corp.

Charles P. Wallick has been named as sales engineer for Curtis Lighting, Inc., in the Minneapolis area, working in association with **Warren D. Anderson.** Mr. Wallick has his office at 638 Builder's Exchange Building, Minneapolis.

1958 Regional Conferences, I.E.S.

Region	Place	Date
Northeastern	Statler Hotel Hartford, Conn.	April 10-11
East Central	John Marshall Hotel Richmond, Va.	April 14-15
South Central and Southeastern	Lafayette Hotel Little Rock, Arkansas	April 24-25
Southwestern	Washington Youree Shreveport, La.	April 28-29
Midwestern	Hotel President Kansas City, Mo.	May 1-2
Inter-Mountain	Whitman Hotel Pueblo, Colo.	May 8-9
South Pacific	El Cortez Hotel San Diego, Calif.	May 14-15
Pacific Northwest	Multnomah Hotel Portland, Oregon	May 22-24
Great Lakes	Sheraton Hotel Rochester, N. Y.	June 23-24

NEW MEMBERS

At the meeting of the I.E.S. Council Executive Committee October 30, in New York City, the following were elected to membership. Names marked * are transfers from Associate Member Grade. Names marked ** are transfers from Student Member Grade.

ALABAMA SECTION

Member:
Kyle, S. C., Tennessee Valley Authority, Wilson Dam, Ala.

Associate Member:
Frank, Roger, Edwin F. Guth Co., Birmingham, Ala.

ALAMO SECTION

Members:
Barnes, S. H., Central Power & Light Co., Corpus Christi, Texas.
Miller, Bill, Bill Miller Associates, Corpus Christi, Texas.

Associate Members:
Beck, S. A., Jr., Central Power & Light Co., Laredo, Texas.
Dykes, Bertram, Westinghouse Electric Corp., Corpus Christi, Texas.
Myers, C. D., Jr., Central Power & Light Co., Alice, Texas.
Nungesser, R. E., General Electric Co., San Antonio, Texas.

ARIZONA SECTION

Member:
Magee, A. E., 1010 N. 5th Ave., Tucson, Ariz.

Associate Member:
Hall, B. J., Arizona Public Service Co., Buckeye, Ariz.

ARK-LA-TEX CHAPTER

Associate Member:
Hightower, K. D., Square D Co., Shreveport, La.

CAPITAL SECTION

Associate Members:
Bott, N. R., U. S. Government, General Services Administration, Washington, D .C.
Epperson, Caroline J., Potomac Electric Power Co., Washington, D. C.

CENTRAL ILLINOIS CHAPTER

Associate Members:
Bloom, A. N., Moe Light Division, Thomas Industries, Peoria, Ill.
Bussman, William, Westinghouse Electric Supply Co., Peoria, Ill.
Jacobson, E. L., Westinghouse Electric Corp., Morton, Ill.

CENTRAL NEW YORK SECTION

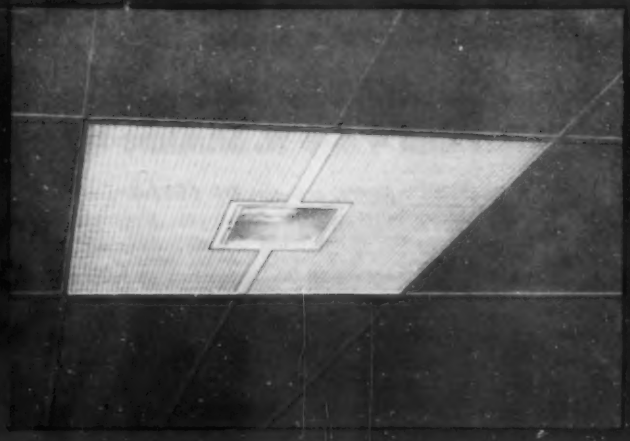
Associate Members:
MacNeill, P. G., 100 Wellwood Drive, Fayetteville, N. Y.
Walden, L. R., Lustra Corp. of America, Brooklyn, N. Y.

(Continued on page 45A)

Kleinhans' Men's Store, Buffalo, New York
fixtures by R & W Wiley, Inc., Buffalo, New York

FOR THE LOUVER THAT ALLOWS YOU COMPLETE FREEDOM OF LIGHTING DESIGN.....

Specify... APL AMERICAN PLASTIC LOUVERS

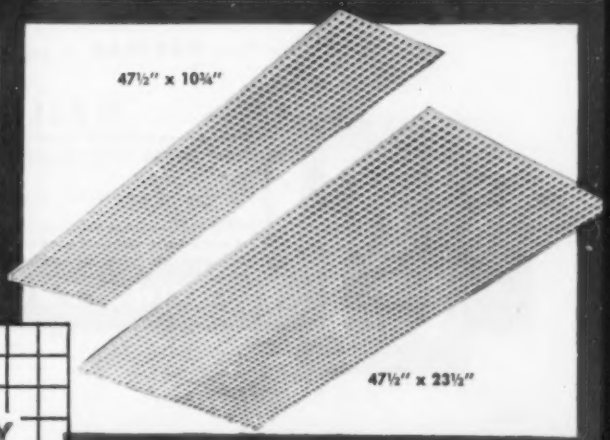


It's a beautiful store—look at the lighting—notice the beautiful installation! For complete ceiling, individual fixtures, troffers, or modular designs, use American Plastic Louvers which combine the finest in lighting with modern beauty. *These interlocking, lightweight plastic louvers fit together without any visible interruption.* Just the right amount of traverse and longitudinal veins give maximum light at minimum brightness without trapping light.

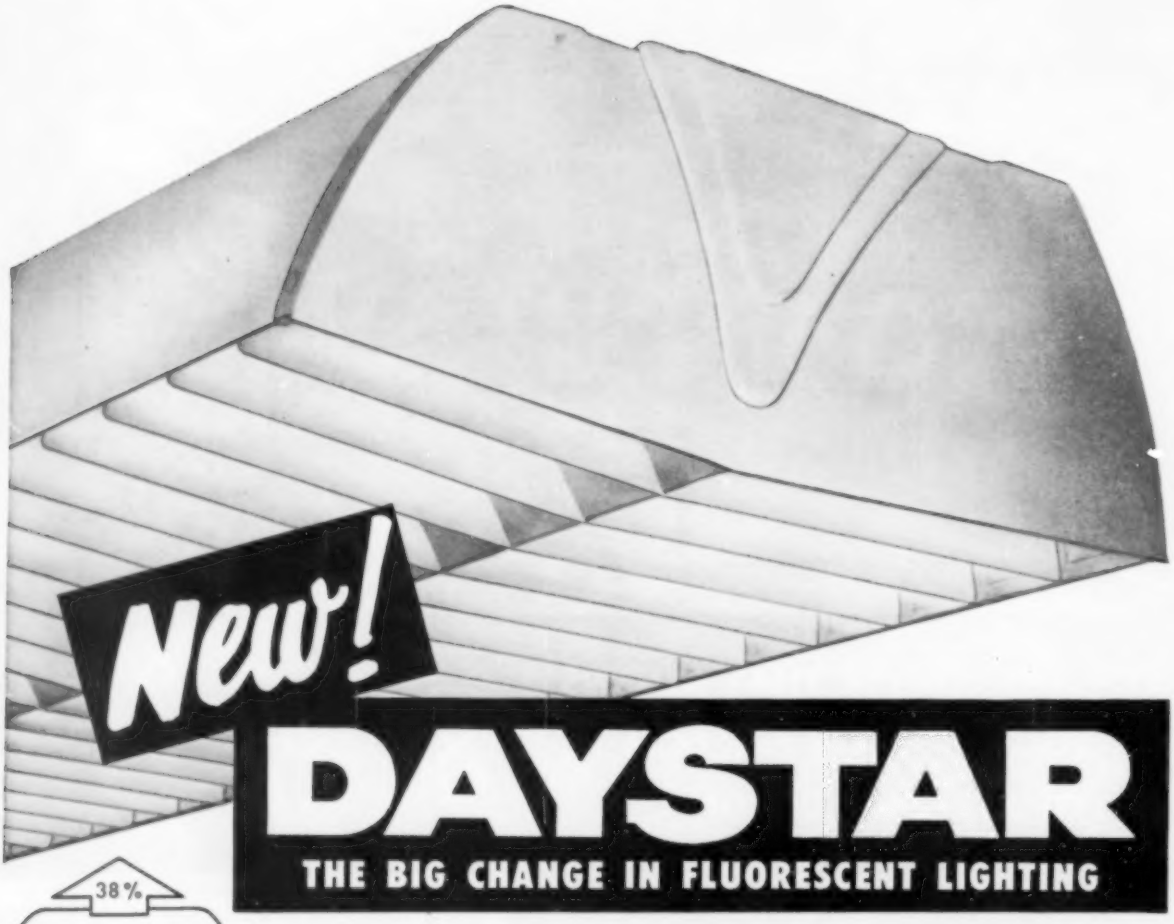
UNEQUALED FEATURES OF AMERICAN LOUVERS...

- Color stable translucent white
- Lighter and easier to handle
- Easier to maintain, with ⅝" cells that permit fingertip grip
- Breaks up sound—reduces room noise
- Permits free air circulation
- Easily sawed, to fit anywhere
- Extreme heat resistance
- 45° x 45° light cutoff

Write for full specifications of American Plastic Louvers today.

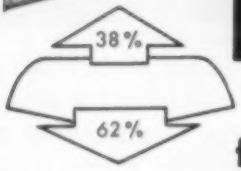


AMERICAN LOUVER COMPANY
4240 NORTH SAYRE • CHICAGO 34, ILLINOIS



New! DAYSTAR

THE BIG CHANGE IN FLUORESCENT LIGHTING



A NEW DIRECT--INDIRECT LUMINAIRE
for 4 ft. 430 M.A. Rapid Start and 4 & 8 ft. Slimline Lamps

Now Lighting Products Inc., pacesetter to the lighting industry, presents **DAYSTAR** a revolutionary new luminaire designed for better lighting in class rooms, offices, commercial and industrial areas . . . wherever high levels of quality illumination are desired.

The New **DAYSTAR** is available in 48 and 96 inch length with 35° crosswise and 25° or 45° lengthwise shielding. 62% of the light is directed down and 38% up.

The side panels are of steel or plastic. The steel panels are permanently attached. The polystyrene plastic panels are readily removable without the use of tools. Eight foot units utilize both side panels and louvers that give an uninterrupted continuity of design. Louvers have a special snap-in catch and are suspended from the channel by safety chains for ease of relamping and maintenance. All metal parts are finished in high reflectance baked white enamel over a phosphatized surface.

The New **DAYSTAR** is completely described and illustrated in color bulletin No. 1503.

MAIL COUPON TODAY!

LIGHTING PRODUCTS INC., Dept. 6-N, Highland Park, Ill. No. 1503

Name_____

Address_____ City_____ State_____

Certified Lighting for a Better America

LPI

LIGHTING PRODUCTS INC., Highland Park, Illinois

(*Continued from page* 42A)

CHICAGO SECTION

Members:
Kempf, V. T., Joseph T. Ryerson & Son, Inc., Chicago, Ill.
Raider, G. K., The Pyle National Co., Chicago, Ill.
Slugg, P. L., The Pyle National Co., Chicago, Ill.

Associate Members:
Kuchar, I. M., A. W. Schwind Inc., Chicago, Ill.
Lundberg, S. K., A. W. Schwind Inc., Chicago, Ill.
Ross, G. W., Sylvania Electric Products Inc., Chicago, Ill.

CHINOOK CHAPTER

Members:
*Bright, M. M., F. D. Bolton, Ltd., Calgary, Alta.
*Vickers, Martin, Angus Butler & Associates, Calgary, Alta.

Associate Members:
Giorgini, Luigi, Angus Butler & Associates, Calgary, Alta.
Johansen, Niels, Simpson Allsopp & Associates, Calgary, Alta.

CLEVELAND SECTION

Members:
*Christensen, Morgan, General Electric Co., Nela Park, Cleveland, Ohio.
*Coakley, Miss Rose, Genueral Electric Co., Nela Park, Cleveland, Ohio.
*Creed, E. I., C & S Lighting Maintenance Co., Cleveland, Ohio.
*Dobras, Q. D., General Electric Co., Nela Park, Cleveland, Ohio.
*Farnham, R. E., General Electric Co., Nela Park, Cleveland, Ohio.
*Fisher, W. S., Jr., General Electric Co., Nela Park, Cleveland, Ohio.
*Hart, A. L., General Electric Co., Nela Park, Cleveland, Ohio.
*Inman, G. E., General Electric Co., Nela Park, Cleveland, Ohio.
*Jensen, J. H., General Electric Co., Nela Park, Cleveland, Ohio.
*Kenty, C. B., Holophane Co. Inc., Newark, Ohio.
*Norton, Cam, Cam Norton Co., Cleveland, Ohio.
*Phillips, D. R., General Electric Co., Nela Park, Cleveland, Ohio.
*Siegrist, G. S., Abolite Lighting Div., The Jones Metal Products Co., W. Lafayette, Ohio.

Associate Members:
Cozadd, C. H., Union Metal Mfg. Co., Canton, Ohio.
Herren, G. E., W. Vance Middough & Associates, Cleveland, Ohio.
Welty, D. E., Holophane Co., Newark, Ohio.
Woolcock, G. T., Cleveland Electric Illuminating Co., Cleveland, Ohio.

CONNECTICUT SECTION

Member:
Hoffman, J. G., Hoffman Engineering Corp., Old Greenwich, Conn.

EASTERN NEW YORK SECTION

Associate Members:
Chapman, J. K., Crane & Nevins Electric Supply Co., Amsterdam, N. Y.
Davey, L. E., Niagara Mohawk Power Co., Hudson, N. Y.

FLORIDA SECTION

Associate Members:
Booth, G. H., Graybar Electric Co. Inc., Tampa, Fla.
Keele, J. H., Graybar Electric Co. Inc., Tampa, Fla.
Sanders, Julia B., Tampa Electric Co., Tampa, Fla.

FOREIGN NON-SECTION

Associate Members:
Go, Pok Oen, University of Indonesia, Bandung, Indonesia.
Last, K. H. W., SLR Electric Ltd., South Harrow, Middlesex, England.

TWO-DAY Maritime Conference in Amherst, N. S., attracted 88 I.E.S. members and guests. Fort Cumberland Hotel in background was floodlighted for the occasion.

Palacio, J., San Juan, Electro Sales Co., Havana, Cuba.
**Rodriquez, F. J., Corporacion Venezulana de Fomento, Caracas, Venezuela.
Sammoun, G., Philips Liban, S. A., Beirut, Lebanon.
Sandelin, B. W., Bergbom & Co. A. B., Malmo, Sweden.

GEORGIA SECTION

Members:
Delaney, R. E., Jr., 1261 Chattahoochee Ave., N. W., Atlanta, Ga.
Hills, D. A., 817 E. Morningside Drive, N. E., Atlanta, Ga.
Humbert, W. F., III, Robert & Co. Associates, Atlanta, Ga.
Nash, H. R., Engineering Associates Inc., Atlanta, Ga.

Associate Member:
Mauldin, W. E., Georgia Power Co., Columbus, Ga.

GOLDEN GATE SECTION

Associate Members:
Bana, A. R., Pacific Gas & Electric Co., San Francisco, Calif.
Bertolone, F. J., Fluorescent Fixtures of California, South San Francisco, Calif.
Devine, B. A., C & C San Francisco Public Utilities Comm., San Francisco, Calif.
Hills, E. H., Safe Electric Co., San Mateo, Calif.
Jewell, J. E., C. J. Holzmueller, San Francisco, Calif.
Jones, C. L., Metropolitan Life Insurance Co., San Francisco, Calif.
Lago, E. N., T. L. Rosenberg Co., Oakland, Calif.
MacDonald, J. P., Fluorescent Fixtures of California, South San Francisco, Calif.
O'Shea, J. F., State Division of Highways, San Francisco, Calif.
Painter, W. C., Clyde E. Bentley Consulting Engineer, San Francisco, Calif.
Parenti, Daniel, Skidmore, Owings & Merrill, San Francisco, Calif.
Parker, H. G., Union Oil Co. of California, San Francisco, Calif.
Pomeroy, G. F., W. P. Fuller & Co., San Francisco, Calif.
Rueger, Mrs. Dallett, North Bay Electric Works, San Rafael, Calif.
Smith, J. A., California Electric Supply, San Francisco, Calif.
Stegmann, Carlos, 479 Merritt Ave., Oakland, Calif.
Willey, J. B., S. C. Epperson, San Francisco, Calif.
Willis, P. T., 333 Kearny St., San Francisco, Calif.

HEART OF AMERICA SECTION

Associate Members:
Glover, R. N., Appleton Electric Co., Kansas City, Mo.
Stewart, J. D., The Empire District Electric Co., Joplin, Mo.

INDIANA SECTION

Member:
Herzer, R. F., General Electric Co., Indianapolis, Ind.

INLAND EMPIRE CHAPTER

Member:
Latenser, J. S., 707 Hutton Bldg., Spokane, Wash.

Associate Members:
Hanson, H. S., Drapes Engineering, Billings, Mont.
Neumayer, E. C., H .E. Bovay Consulting Engineers, Spokane, Wash.
Stebbins, J. A., Joseph M. Doyle, Spokane, Wash.

IOWA SECTION

Associate Members:
Mielkey, Roland, Clinton Electric Supply Inc., Clinton, Iowa.
Olson, W. H., Iowa Illinois Gas & Electric Co., Iowa City, Iowa.
Strub, F. A., Iowa Electric Light & Power Co., Cedar Rapids, Iowa.

MIAMI VALLEY SECTION

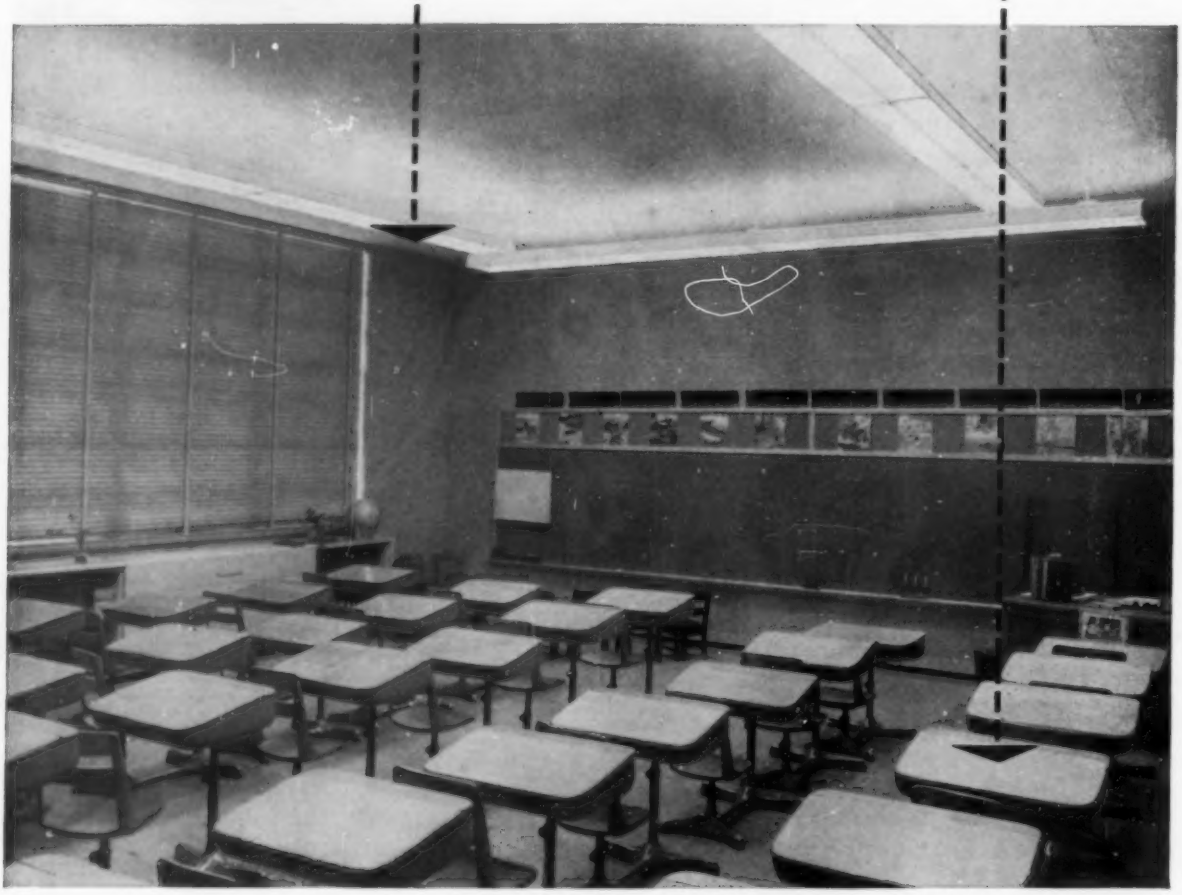
Associate Members:
Allen, G. P., The W. W. Electric Co., Springfield, Ohio.
Beecroft, W. C., Gary Roof & Associates, Dayton, Ohio.
Meinert, W. J., Hubbard & Co., Columbus, Ohio.
Randall, Miss Jewell, Dayton Power & Light Co., Dayton, Ohio.
Thompson, Frieda, Dayton Power & Light Co., Dayton, Ohio.
Weekley, A. L., Dayton Power & Light Co., Dayton, Ohio.

Student Member:
Spencer, J. K., Helmig, Lienesch & Associates, Dayton, Ohio.

(*Continued on page* 56A)

DECIDEDLY BETTER
DAY-BRITE
Lighting Fixtures

HERE . . . MEANS BETTER SEEING HERE

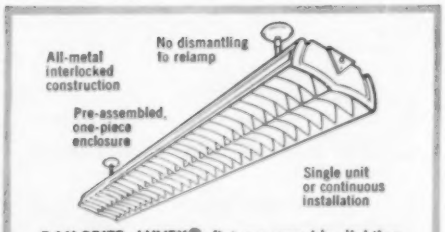


Day-Brite LUVEX® fixtures in a "U" pattern reduce fatigue and eyestrain, create a pleasant work atmosphere in classrooms of the Longfellow School, Massillon, Ohio.

When Light's Right, Learning's Easy!

87% of a child's education comes through his eyes. That's why you cannot afford to compromise on lighting. Always specify Day-Brite—the nation's first choice in lighting fixtures. For proof of Day-Brite superiority, make your own comparison!

Day-Brite Lighting, Inc., 5432 Bulwer Ave., St. Louis 7, Mo.
Day-Brite Lighting, Inc., of Calif., 530 Martin Ave., Santa Clara, Calif.

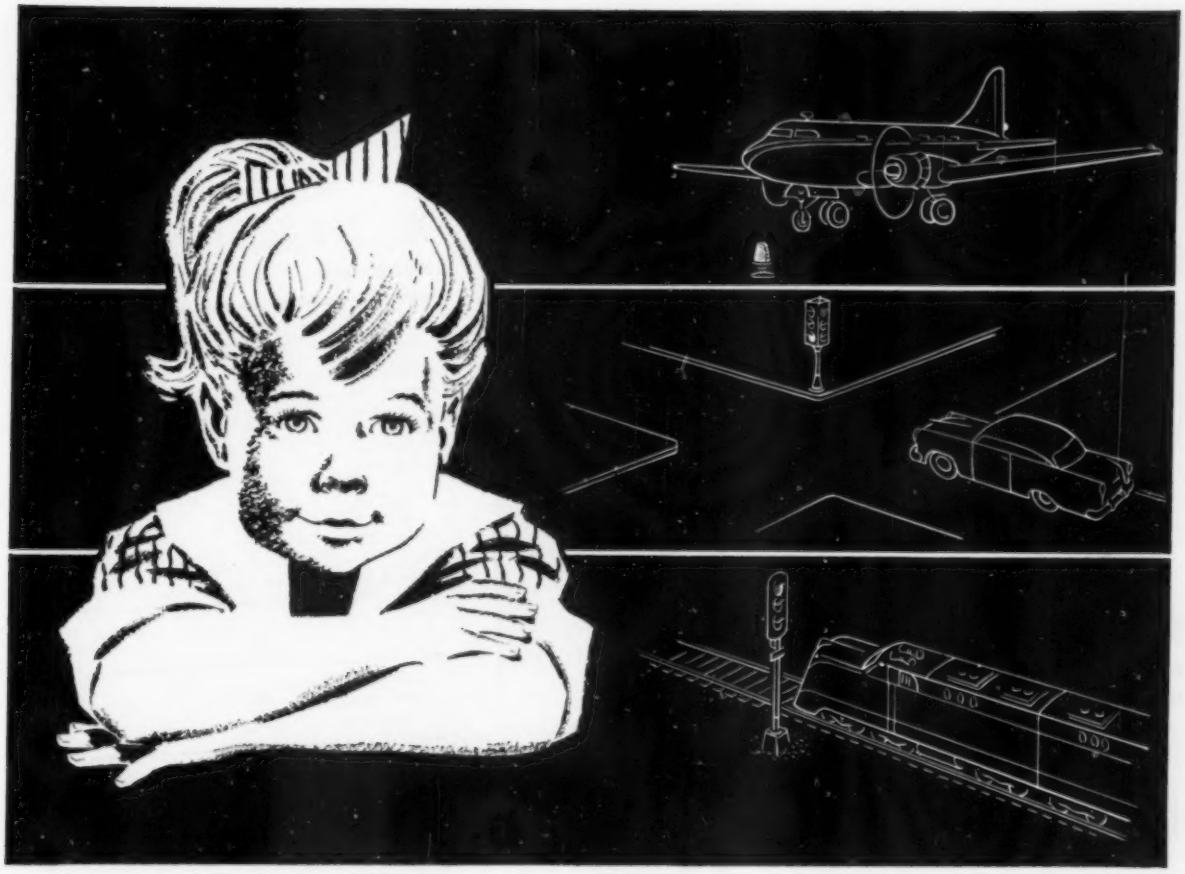


DAY-BRITE LUVEX® fixtures provide lighting quality, quantity and economy—three requirements of good classroom illumination. Half up and half down lighting. Available in 2- or 4-lamp units in 4′ and 8′ lengths.

71185

DECIDEDLY BETTER
DAY-BRITE
Lighting Fixtures

NATION'S LARGEST MANUFACTURER OF COMMERCIAL AND INDUSTRIAL LIGHTING EQUIPMENT



Where her safety is involved . . .

you can depend on **Kopp** *engineered glass*

Why? Because Kopp glass is precisely designed for its specific job. Whether your requirements call for color transmission, light distribution, beam control, dimensional accuracy or any other individual characteristic—Kopp engineers design industrial glass products to meet those exact needs.

Furthermore, a Kopp-engineered product is manufactured of the finest, carefully-formulated ingredients. Every step in the production process is individually and rigidly controlled. Each product is thoroughly inspected and tested to assure highest quality and uniform dependability. That's why users of Kopp glass always receive top-quality performance—mighty important where human safety is involved.

Only a few of more than 1000 highly-specialized items made from over 100 varieties of glass by Kopp are shown below. Call us today for assistance in solving any industrial glass application problem which you may have.

KOPP GLASS

KOPP GLASS, Inc.

Swissvale, Pennsylvania

If your fluorescent lamp sizes are on

THIS LIST

then there now are ballasts to give you up to

One Third More Light!

DOUBLE-LONG LAMP LIFE!

Westinghouse

HIgh-EFFiciency BALLASTS

are co-ordinated to specific electrical requirements of each particular fluorescent lamp!

If your fluorescent lamps are on this list (at right) then you, too, can save *appreciable* amounts of money! — in lighting costs! — in prolonged lamp-life!

This is possible because *all* fluorescent lamps require ballasts *specifically suited* to *each* lamp's *own particular* operating characteristics!

Ballasts *unsuited* to given lamps can *reduce their light-output one-third!* — can *often* cut *lamp-life in half!* And the same is true of ballasts seemingly "matched" well enough — but not manufactured up to the standards necessary for those included in the Westinghouse HIgh-EFFiciency BALLAST list!

So, have your ballasts checked—at *the very first good opportunity!*—for *all three* of the following seals that distinguish *economical* ballast performance!

J-04421

Westinghouse

HIgh-EFFiciency BALLASTS

available now for all the following lamps:

LAMP TYPE	LAMP WATTS	CIRCUIT VOLTAGE
preheat		
40T12	1-40	118 v
40T12	2-40	118 v
40T12	2-40	277 v
40T12	3-40	118 v
90T17	2-90	118 v
90T17	2-90	265 v
90T17	4-90	265 v
rapid start		
40T12 rs	1-40	118 v
40T12 rs	1-40	265 v
series • 430 ma		
40T12 rs	2-40	118 v
40T12 rs	2-40	277 v
series • 800 ma		
48T12 rs	2-60	118 v
48T12 rs	2-60	277 v
96T12 rs	2-100	118 v
96T12 rs	2-100	265 v
slimline — 425 ma		
48T12	1-38	118 v
48T12	1-38	265 v
72T12	1-55	188 v
72T12	1-55	277 v
96T12	1-74	118 v
96T12	1-74	277 v
lead-lag		
48T12	2-38	118 v
48T12	2-38	277 v
72T12	2-55	118 v
72T12	2-55	265 v
96T12	2-74	118 v
96T12	2-74	265 v
series		
72T12	2-55	118 v
72T12	2-55	277 v
96T12	2-74	118 v
96T12	2-74	265 v

For special requirements not listed above, contact your nearest Westinghouse office, your own local Westinghouse Distributor, or write to Westinghouse Electric Corporation, Lighting Division, Edgewater Park, Cleveland, Ohio.

This Underwriters Laboratories Seal means that the ballast on which it appears is electrically *safe!*

This Certified Ballast Manufacturer's Seal means that the ballast meets rigid technical operating requirements.

This Westinghouse seal means that ballasts so identified *fulfill or exceed all CBM requirements!* — are warranted the distinction of inclusion on the Westinghouse HIgh EFFiciency BALLAST list — *yet cost no more* than ballasts that *may* be *wasting 1/3 your lighting potential! — that may be "killing" your lamps mid-way in their service life! Look* for the *Westinghouse* seal!

YOU CAN BE SURE... IF IT'S Westinghouse

Uni-Race, which houses branch circuit wires, assembled and wired on the floor. 1

Light, rigid Uni-Race assembly, up to 24' long, is easily lifted and hung. 2

Fixtures simply snap into place. The plug in the fixture engages receptacle in Uni-Racé. 3

3 easy steps to better lighting

only the Gibson Ortho offers these advantages

SPEEDY INSTALLATION. Contractors throughout the country report that a complete Gibson installation takes, on the average, only 22 man-minutes per fixture, including all wiring, stems, lamping and mounting — a mere fraction of the time required by conventional installations.

AUTOMATIC ALIGNMENT. Rigidity of Uni-Race holds fixtures in precise alignment.

COMPLETE FLEXIBILITY. Ortho fixtures can be mounted in continuous rows or at intervals of 4, 8, 12 or more feet. Spacing can be rearranged at any time without tools. Two-light fixtures can be replaced by four-light fixtures and vice versa.

NO ON-JOB-FIXTURE STORAGE. Fixtures need not be delivered until premises are painted. They are then snapped into place on the pre-hung Uni-Race, clean and factory-fresh.

NO WELDED JOINTS. The Ortho 77 is the finest fixture money can buy. One reason is that all adjoining parts are interlocked by screws, rods or tabs. No welded parts to come loose.

ortho-77

Patent Pending

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GIBSON Manufacturing Co.

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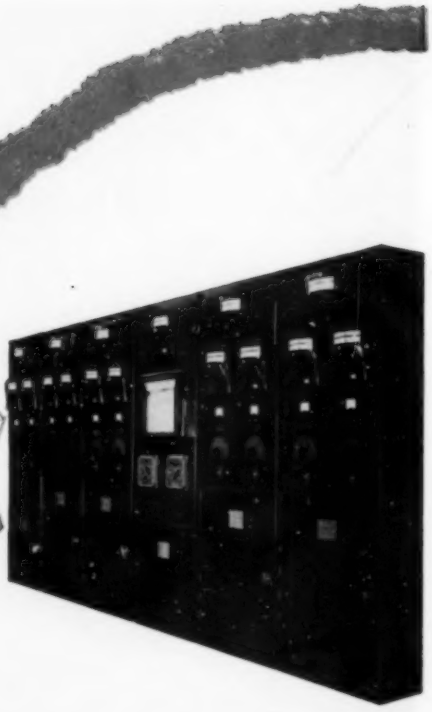

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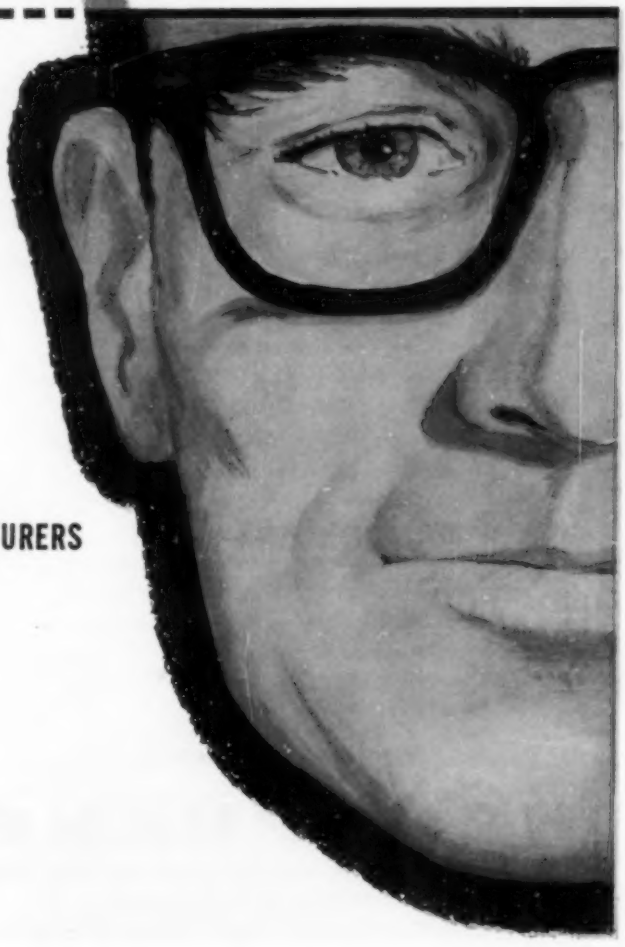

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a new hinged design*
in ceiling
pan fixtures by

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Perfeclite now offers a new **hammer lock** design in incandescent ceiling pan lighting fixtures. No other ceiling pan fixture on the market today has all these engineering features:

- Globe opens on **hinge** for quick easy cleaning and relamping.
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- Minimum amount of metal, maximum amount of glass results in **highest light efficiency.**

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HH-9	8″	2- 40 W
HH-11	10″	2- 60 W
HH-13	12″	2- 75 W
HH-15	14″	2-100 W
HH-17	16″	3-100 W

Send for new Perfeclite Catalog 956 giving full information on our entire line of Commercial Incandescent Fixtures and Exit Units.

Fixtures are Underwriters Laboratories, Inc. approved.

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Says *Mr. Edward R. Hansen, President, Meade Electric Company, Inc.*

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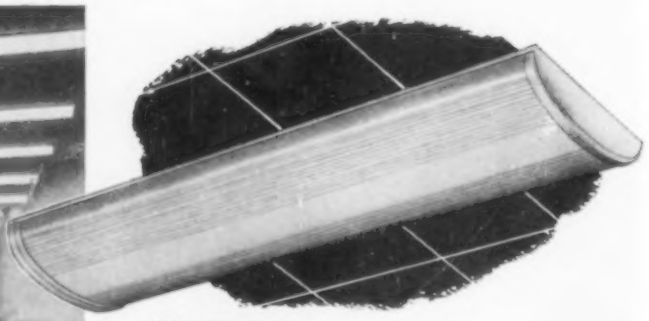
Ultra-Lux lighting at the Chicago Printed String Company



GARCY'S New Ultra-Lux for the 'Built-In' Look with Surface-Mounted Cost

Garcy Ultra-Lux, with its shallow profile is ideal for low ceiling lighting. Only 3¼" deep, surface-mounted Ultra-Lux gives the appearance of a recessed fixture. Yet, the depth is consistent with good light distribution and brightness control.

Ultra-Lux has two basic parts—the completely assembled chassis and separately packaged shield made of Koppers EVENGLO*, guaranteed not to warp or discolor.

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new luminaire . . .

with light-control lens of Plexiglas

Molded of PLEXIGLAS® acrylic plastic, the prismatic enclosure of this recently introduced fluorescent luminaire contributes many basic design advantages:

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Dimensional Stability and Freedom from Discoloration insure long term efficiency, beauty and economy.

Write today for the names of manufacturers of fluorescent luminaires featuring molded PLEXIGLAS enclosures.

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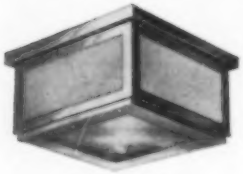
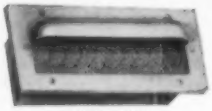
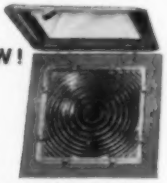


NO. 1141
Surface Square with control lens

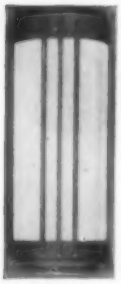


NO. 294
Recessed Step Light
Sprayed bronze finish on cast aluminum, wire plate glass.

NEW!



Recessed 1100 Line
With spring hinge drop face



NO. 1833
Half Cylinder Pocket, all copper metal.

NO. 1791
Bracket Lantern, all copper metal.

NO. CH-215
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All copper metal.

NO. 1150 Recessed Box with Two Gimbal Ring Units (PAR-150W floodlamps and three 100W incandescent.

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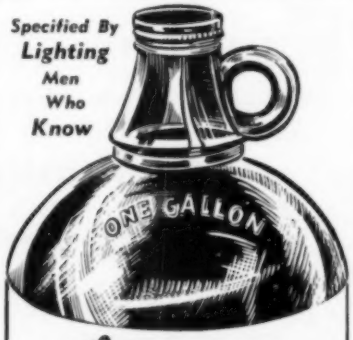

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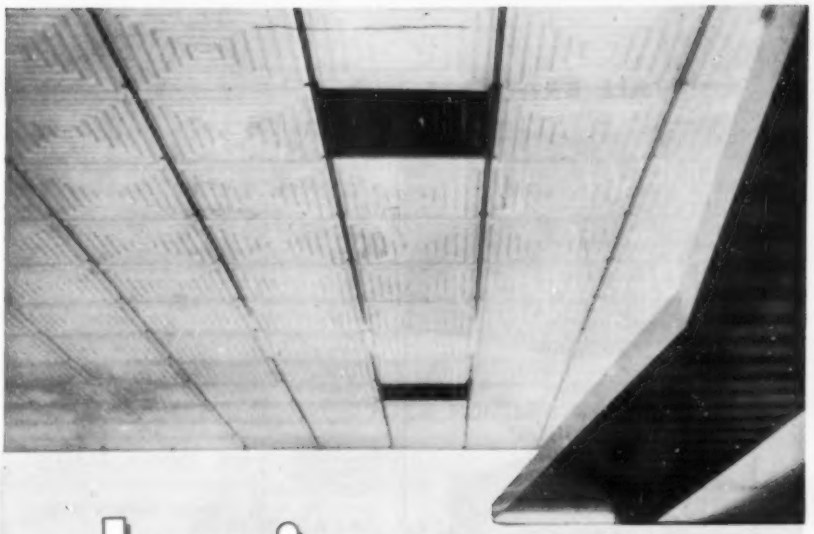
(*Continued on page* 58A)



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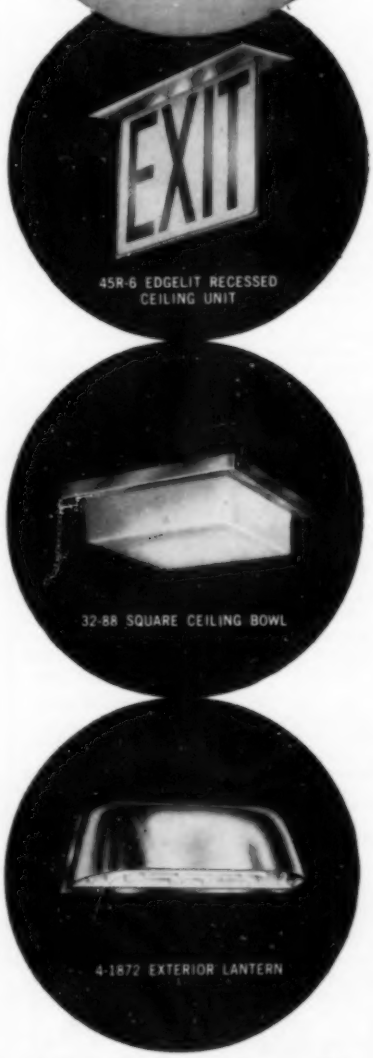

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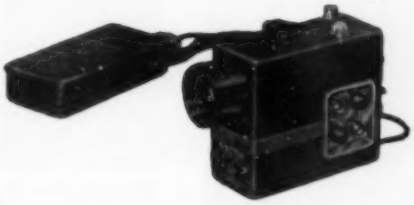

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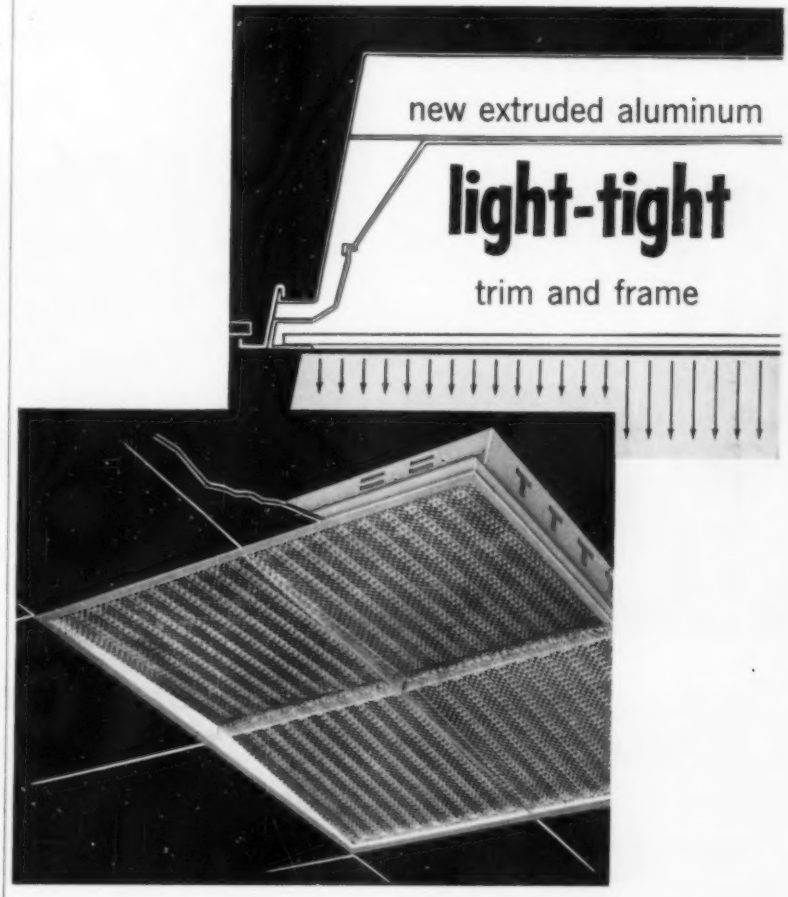

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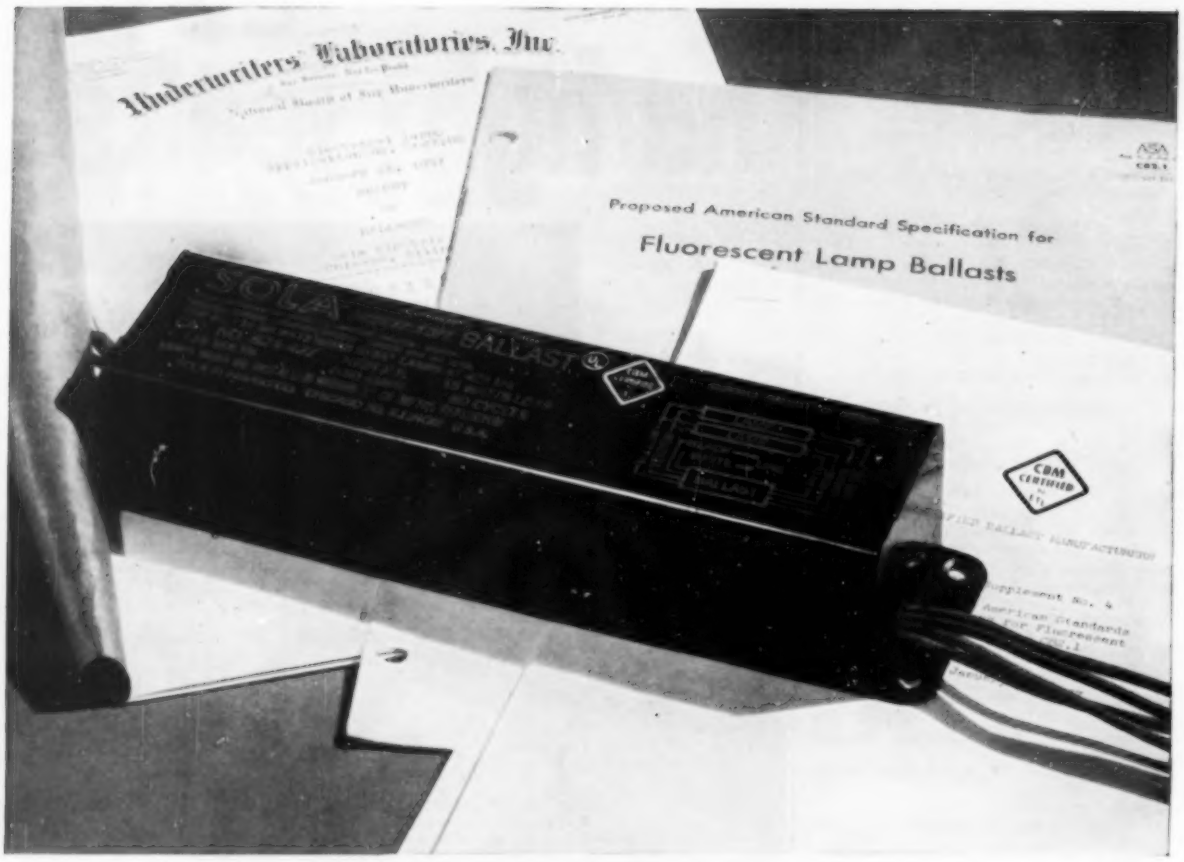

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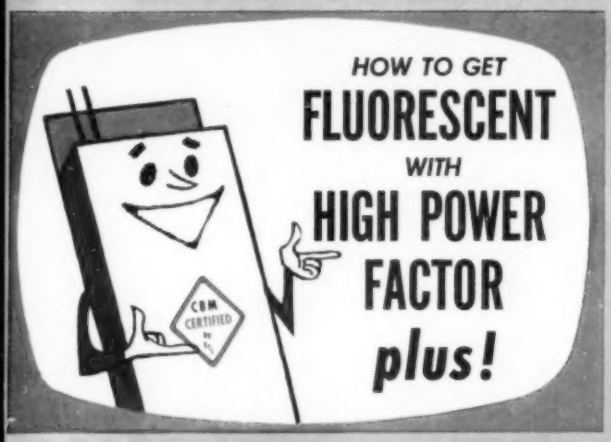

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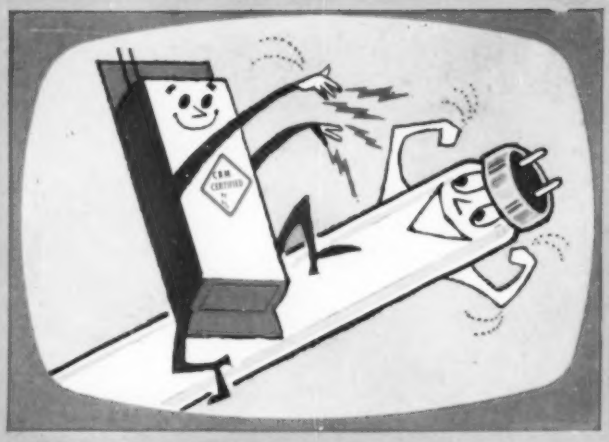

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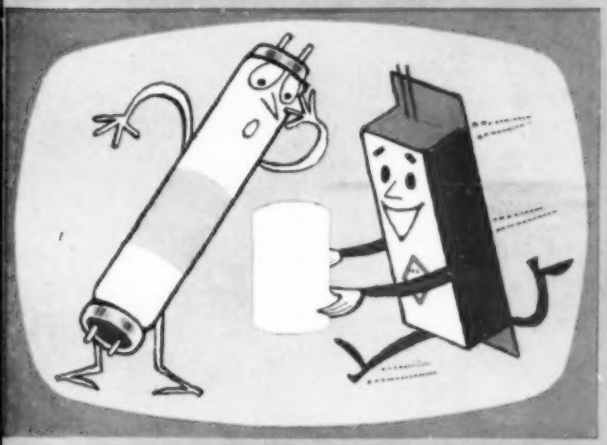

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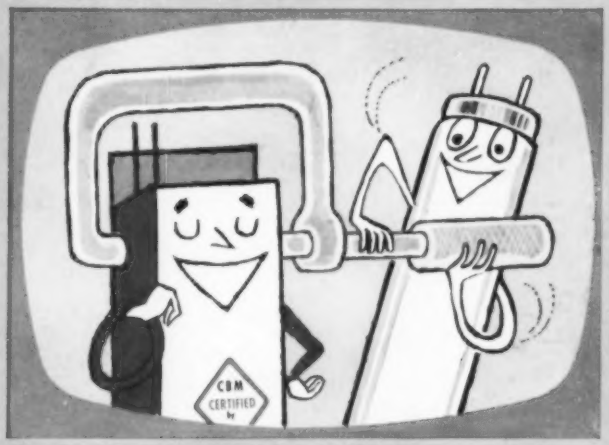

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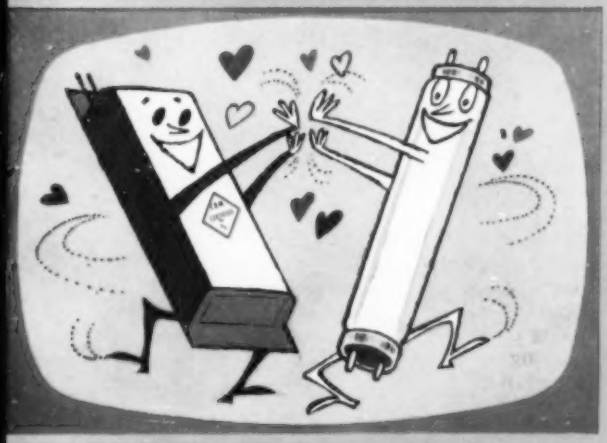

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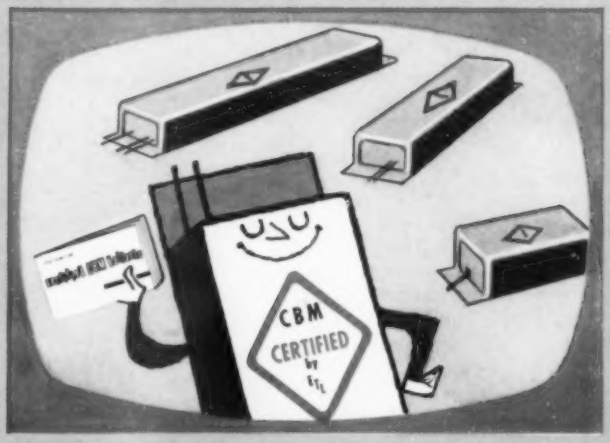

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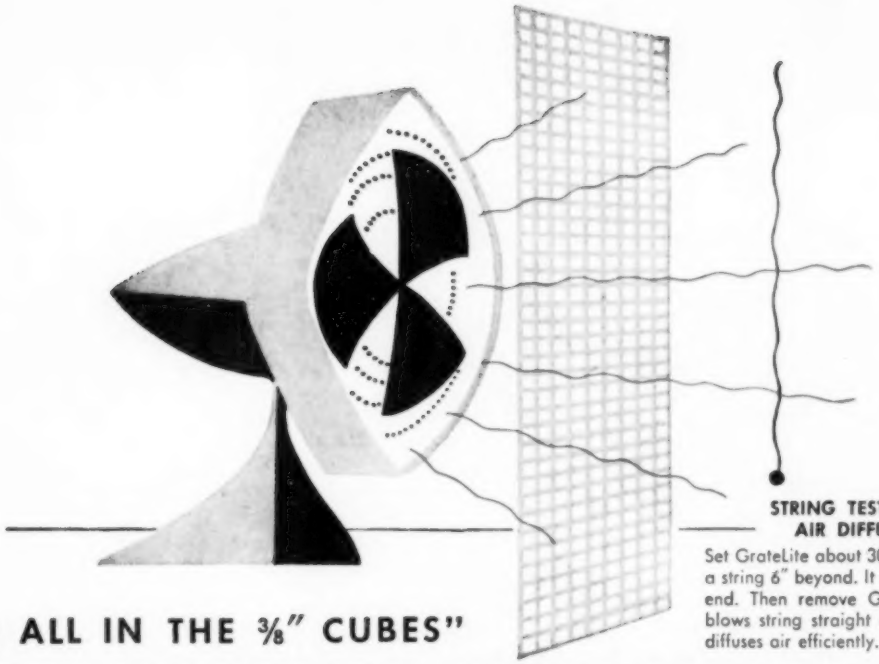

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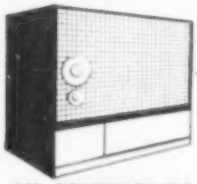

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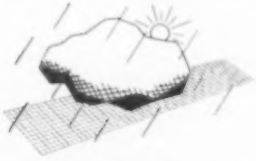

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STANDS ROUGH HANDLING!

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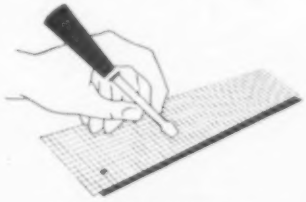

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GrateLite doesn't scar easily—or rip or break when dropped or struck by a tool. Fingernails can't mar its usefulness. No "black eyes," no damaged cubicles to destroy overall beauty and efficiency.

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